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THE SCUTATE TICKS, OR IXODIDAE, OF INDONESIA[1]

By George Anastos

Department of Zoology, Miami University, Oxford, Ohio

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[1] The material in this paper was included in a thesis, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, at Harvard University.

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INTRODUCTION

This work is a revisional study of the ticks of the family Ixodidae occurring in Indonesia (former Netherlands East Indies). It is based upon the collections of museums in the United States and upon the material sent to Dr. J. C. Bequaert in 1940 by Professor F. C. Kraneveld, at that time at the Veeartsenij kundig Instituut, Buitenzorg, Java, now at the Rijksuniversiteit, Utrecht, Netherland. Material was also received from Dr. E. de Boer of the Veterinary Institute of the Department of Agriculture and Fisheries at Buitenzorg, Java. The East Indian tick collection of the Museum of Comparative Zoology, Cambridge, Massachusetts, is the largest studied, and it contains twenty species. The Rocky Mountain Laboratory, Hamilton, Montana, has an equally fine collection containing eighteen species. The collection of the American Museum of Natural History, New York, is small and contains only three East Indian species. The collection of the Chicago Natural History Museum has only one species represented. The material received from Dr. Kraneveld, hereafter referred to as the Kraneveld collection, consists of approximately twenty thousand specimens with twelve species represented. I also saw two species sent to the Rocky Mountain Laboratory by the late Dr. P. Schulze of Rostock, Germany. The collection of Dr. de Boer contained only one species of interest.

The synonymy is extralimital in all cases, except for the species world-wide in distribution, such as *Rhipicephalus sanguineus* and to a lesser extent *Boophilus microplus*. The synonymy of previous workers is critically examined, and a discussion of the new synonymy is included in the text under each species.

In the spelling of place names, I follow the National Geographic Society, Map of Southeast Asia and Pacific Islands, 1944. Names not located on this map are taken from Stielers Hand Atlas, 1930–1931, and the Century Atlas, 1901.

In this work I take a broad view of a "species", and I sink many of the purely geographical subspecies described by Schulze. For example, the characters used by Schulze to separate four subspecies of *Amblyomma testudinarium* are color, pattern of ornamentation and size; all are variable and have little, if any, taxonomic value. The primary reason for his subspecies appears to be geographical. Since these ticks were introduced into many areas throughout the Oriental Region in recent times, and since they are still being spread by livestock, there remains no basis for recognizing these subspecies. I examined approximately one hundred specimens of *A. testudinarium* from numerous localities in the Oriental Region, and since I can find no reliable characters by which they can be separated, I regard them all as one species. In the case of *Rhipicephalus haemaphysaloides,* where reliable morphological characters can be correlated with geographical distribution, there is a basis for recognizing subspecies. I also take a broad view regarding genera, and I believe that they should be subdivided only when absolutely necessary. The history of acarology shows clearly that great care should be exercised in the erection of new genera or higher groups.

The arrangement in the list of reptilian hosts follows Loveridge (1945, *Reptiles of the Pacific World*), and the names are according to the Catalogue of Reptiles in the Museum of Comparative Zoology. In the list of avian hosts, which is very small, the arrangement is that of Chasen (1935, Bull. Raffles Mus., **11**, pp. 1–389). The arrangement and the names in the list of mammalian hosts are for the most part taken from Chasen (1940, *Op. cit.,* **15**, pp. 1–209), with the rodent names based upon Ellerman (1940, *The Families and Genera of Living Rodents,* Vol. **1**; 1941, Vol. **2**).

The drawings are made from alcoholic specimens, with the aid of a net reticule placed in the ocular of a binocular-dissecting microscope. Magnifications ranging from twenty-five to one hundred times are most suitable for study. Detail is more clearly seen when the specimen is viewed dry, and drying will also bring out the pattern of the scutal ornamentation.

The keys to genera and species are artificial and based upon several characters to make identification more certain. Future studies based on breeding experiments may change existing views on the characters regarded as diagnostic, but in these keys an attempt is made to select those characters which are felt to be reliable and most diagnostic.

In the bibliographies the abbreviations n and l stand for nymph and larva respectively.

Acknowledgments. To Dr. J. C. Bequaert, Curator of Insects, Museum of Comparative Zoölogy, I owe a great deal for what has gone into this study; it was at his suggestion that I began this work and by his constant guidance that I was able to reach a better understanding of the ticks. Dr. F. M. Carpenter, Professor of Zoology, Harvard University, has given me every encouragement and has been most helpful with aid and advice relative to the many problems in morphology and taxonomy. To Mr. G. M. Kohls of the Rocky

Mountain Laboratory, Hamilton, Montana, I am greatly indebted for his kindness in rendering me every assistance and for making my summer at the laboratory such a pleasant experience. Through the kindness of the late Dr. R. R. Parker, Director of the Rocky Mountain Laboratory, I was able to study their large, excellent collection and to bring material to Harvard for further study.

To my wife Angelica I owe the greatest debt of gratitude for her understanding kindness and assistance during the preparation of this work.

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MORPHOLOGY

The identification of genera in the ticks is fairly simple, and in many cases specimens can be sorted to genus without need of magnification. The identification of species is more difficult, for within a genus the species are often uniformly monotonous in structure and lack good characters for separation. Even the very few characters present vary within limits. This range of variation is not known for most ticks, and it can only be determined by controlled breeding experiments wherein the F-2 generation of selected extreme females from an F-1 generation of one female is carefully studied. The developmental stages and the behavior patterns are known to vary in those ticks having wide distribution, and these factors must also be taken into consideration when defining the limits of a species. Geographical distribution alone can not be used in separating species, for many species of ticks have been transported into new localities with domestic animals in fairly recent times.

Since all the East Indian specimens examined were preserved, it was necessary to rely upon external, morphological characters exclusively. Data regarding biology and host relationships have been helpful to a certain degree. The dissections I made of numerous living ticks of other species, in an attempt to find characters which might be helpful in separating these forms, proved inconclusive. As with the external features, the internal anatomy appears to be very uniform. A study of the mouthparts also failed to show any-

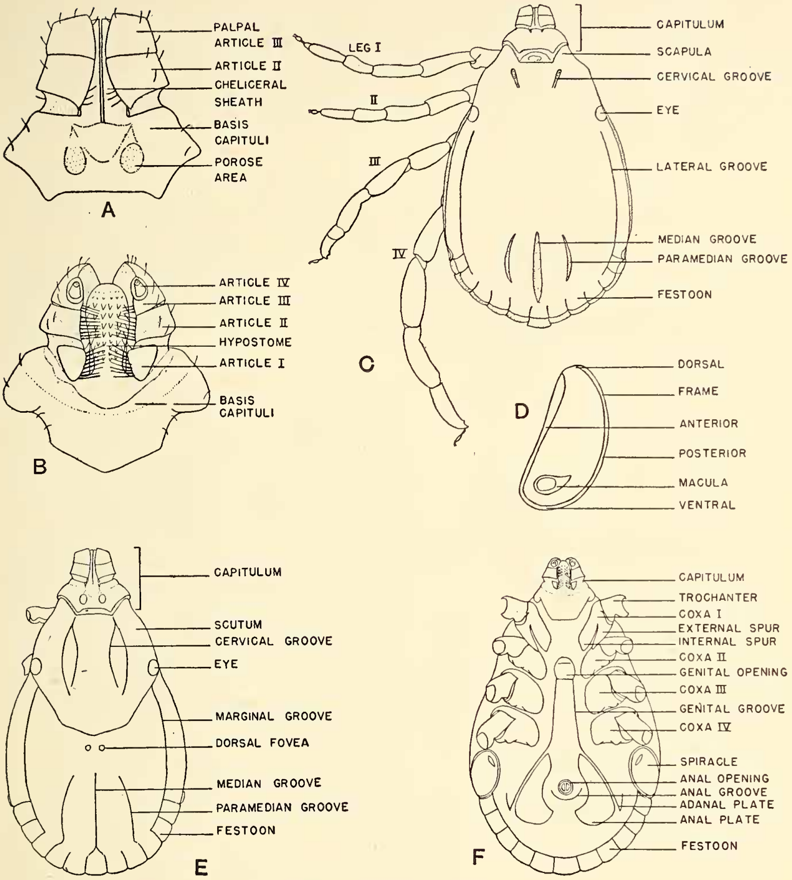

Fig. 1. External morphology of *Rhipicephalus haemaphysaloides* Supino: A, capitulum of female in dorsal view; B, same in ventral view; C, male in dorsal view; D, spiracle of female; E, female in dorsal view; F, male in ventral view.

thing significant; a few differences noticed do not warrant the destruction of valuable specimens. Not too much value should be attached to the pattern of the scutal ornamentation, for it varies considerably wherever present.

For a detailed treatment of tick morphology in relation to taxonomy and for definitions of terms used, the reader is referred to Nuttall, Warburton, Cooper and Robinson, 1911–1926, *Ticks: A Monograph of the Ixodoidea.* Most of the descriptive terms used in the present work are explained in Fig. 1.

GENERAL RANGE OF SPECIES

The ticks of Indonesia are still far from being completely known and extensive collecting remains to be done on many islands in this area. Excluding from consideration those ticks found on domestic animals, certain generalizations can be drawn from the known reliable records. Those species occurring on the islands near Asia are generally identical with the mainland fauna. Proceeding eastward along the East Indies, the species common to Asia become fewer and fewer, and nearly all are absent from New Guinea which has a fauna nearly all its own. A very few species occurring on New Guinea, however, are found in the more western East Indies.

Sumatra, Java and their adjacent islands have the greatest number of species. Though their faunas are similar and chiefly of Asiatic origin, many species are restricted to this group. The Lesser Sunda Islands, from Bali to Banda, have a smaller representation of species than the preceding group; a few species are restricted to this region, whereas others show affinities to the Sumatra-Java fauna or to the New Guinea fauna. Nothing definite can be said for the Celebes and the Halmahera groups at this time; with the exception of one species, *Amblyomma babirussae,* known only from Celebes, the rest are common ticks of domestic animals introduced into this area.

Several species have found domestic animals suitable hosts, and the habits of domestic animals have favored their increase in numbers and their distribution throughout the islands. In this group belong *Amblyomma testudinarium, Boophilus microplus, Haemaphysalis bispinosa, H. cornigera, H. hystricis, H. papuana, H. wellingtoni, Rhipicephalus haemaphysaloides, R. sanguineus* and *Dermacentor auratus.*

Several species, taken off wild animals primarily, are definitely of Asiatic origin and have advanced eastward into Indonesia: *Am-*

blyomma crenatum, A. helvolum, A. javanense, A. malayanum, Aponomma lucasi, Haemaphysalis koningsbergeri and *Ixodes granulatus.*

The following species are restricted to this territory and are unknown from other localities in the Oriental Region: *Amblyomma babirussae, A. geoemydae, A. robinsoni, Aponomma barbouri, A. komodoense, Haemaphysalis hylobatis, H. toxopei, H. traguli, Ixodes praematurus* and *I. spinicoxalis.* Within this group *Amblyomma robinsoni* and *Aponomma komodoense* are known only from Komodo Island.

Amblyomma cyprium and *Aponomma trimaculatum* appear to be of New Guinea origin and for the present are placed in this group. *Amblyomma cordiferum* has a peculiar distribution being known from three widely separated localities, Siam, Krakatau Island and Banda Island. Future records may fill the gaps in this distribution.

Distribution According to Islands[2]

Simeuloeë: *Amblyomma helvolum; Aponomma trimaculatum; Haemaphysalis koningsbergeri.*
Babi: *Amblyomma helvolum; Aponomma lucasi* (?); *Haemaphysalis hystricis.*
Nias: *Boophilus microplus.*
Siberoet: *Haemaphysalis hystricis.*
Sumatra: *Amblyomma crenatum; A. geoemydae; A. helvolum; A. javanense; A. malayanum; A. testudinarium; Aponomma lucasi; A. trimaculatum; Boophilus microplus; Dermacentor auratus; Haemaphysalis bispinosa; H. cornigera; H. hylobatis; H. hystricis; H. koningsbergeri; H. papuana; H. wellingtoni; Ixodes granulatus; I. spinicoxalis; Rhipicephalus haemaphysaloides haemaphysaloides; R. haemaphysaloides pilans; R. sanguineus.*
Berhala: *Amblyomma helvolum; Haemaphysalis traguli.*
Pandang: *Amblyomma testudinarium.*
Bengkalis: *Haemaphysalis hystricis.*
Riouw: *Haemaphysalis hystricis.*
Bintan: *Amblyomma testudinarium.*
Krakatau: *Amblyomma cordiferum.*

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[2] Excludes Borneo, Aroe Islands, Amboina, Kai Islands and Netherlands New Guinea.

Java: *Amblyomma crenatum; A. helvolum; A. javanense; A. testudinarium; Aponomma barbouri; A. lucasi; Boophilus microplus; Dermacentor auratus; Haemaphysalis bispinosa; H. cornigera; H. koningsbergeri; H. papuana; H. traguli; H. wellingtoni; Ixodes granulatus; I. spinicoxalis; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Madoera: *Boophilus microplus; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Karimoendjowo: *Haemaphysalis cornigera; H. hystricis; H. bispinosa; Boophilus microplus.*

Bawean: *Haemaphysalis koningsbergeri; Ixodes granulatus.*

Bali: *Amblyomma testudinarium; Boophilus microplus; Haemaphysalis bispinosa; H. cornigera; H. hystricis; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Lombok: *Rhipicephalus haemaphysaloides pilans; Boophilus microplus; Amblyomma testudinarium.*

Soembawa: *Haemaphysalis bispinosa; H. cornigera; H. papuana; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Komodo: *Amblyomma helvolum; A. robinsoni; Aponomma komodoense.*

Flores: *Amblyomma cyprium cyprium; A. helvolum; A. testudinarium; Boophilus microplus; Haemaphysalis bispinosa; Rhipicephalus haemaphysaloides pilans.*

Alor: *Haemaphysalis papuana; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Banda: *Amblyomma cordiferum.*

Soemba: *Boophilus microplus; Haemaphysalis cornigera; Rhipicephalus haemaphysaloides pilans; R. sanguineus; Amblyomma testudinarium.*

Sawoe: *Rhipicephalus haemaphysaloides pilans.*

Timor: *Boophilus microplus; Haemaphysalis papuana; Ixodes praematurus; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Roti: *Rhipicephalus haemaphysaloides pilans.*

Tanimbar: *Amblyomma helvolum; Boophilus microplus.*

Boeroe: *Amblyomma babirussae* (?); *Haemaphysalis toxopei.*

Boö: *Amblyomma testudinarium.*

Saparoea: *Boophilus microplus; Haemaphysalis papuana; Rhipicephalus sanguineus.*

Soela: *Boophilus microplus; Haemaphysalis bispinosa; H. papuana.*

Ternate: *Amblyomma cordiferum* (?); *Aponomma lucasi* (?).

Halmahera: *Haemaphysalis papuana; Boophilus microplus.*

Celebes: *Amblyomma babirussae; A. cyprium cyprium; A. testudinarium; Boophilus microplus; Haemaphysalis bispinosa; H. hystricis; H. papuana; Rhipicephalus haemaphysaloides pilans; R. sanguineus.*

Sangihe: *Haemaphysalis papuana; Boophilus microplus.*

Boetoeng: *Boophilus microplus.*

Distribution According to Hosts

Reptilia

Order Testudinata

Family Emydidae

Geoemyda spinosa (Gray), Spiny Hill-tortoise.—*Amblyomma geoemydae.*

Order Squamata

Suborder Sauria, or Lacertilia

Family Scincidae

Mabuya multifasciata (Kuhl), Many-striped Skink.—*Amblyomma helvolum.*

Family Varanidae

Varanus komodoensis Ouwens, Komodo Land-monitor.—*Amblyomma robinsoni, A. helvolum, Aponomma komodoense.*

Varanus salvator (Laurenti), Common Water-monitor.—*Amblyomma helvolum, A. javanense, Aponomma lucasi, A. trimaculatum.*

Varanus indicus (Daudin), Indies Water-monitor.—*Amblyomma helvolum.*

Suborder Serpentes, or Ophidia

Family Boidae

Python reticulatus Schneider, Reticulated Python.—*Amblyomma helvolum, Aponomma barbouri.*

Python sp., Python.—*Amblyomma cordiferum.*

Family Colubridae

Ptyas korros (Schlegel), Rat-snake.—*Amblyomma helvolum.*

Ptyas mucosus (Linnaeus), Greater Rat-snake.—*Amblyomma helvolum.*

Boiga dendrophila (Boie), Mangrove Snake.—*Amblyomma helvolum.*

Coluber oxycephalus Boie, Ular selenseng (Malayan name).—*Amblyomma helvolum.*

Family Elapidae

Ophiophagus hannah (Cantor), King Cobra, or Hamadryad.—*Amblyomma helvolum.*

Naja naja leucodira Boulenger, Hooded Cobra.—*Amblyomma helvolum.*

Aves

Family Timaliidae

Babbler.—*Ixodes praematurus.*

Family Turdidae

Geokichla sp., Ground Thrush.—*Ixodes praematurus.*

Family Zosteropidae

Zosterops sp., White-eyes.—*Ixodes praematurus.*

Family Phasianidae

Gallus gallus (Linneaus), Domestic chicken.—*Haemaphysalis wellingtoni.*

Family Anatidae

Anser anser (Linnaeus), Domestic goose.—*Haemaphysalis wellingtoni.*

Mammalia

Order Insectivora

Family Tupaiidae

Tupaia glis hypochrysa Thomas, Common Tree Shrew.—*Ixodes granulatus.*

Tupaia javanica occidentalis Robinson and Kloss, Common Tree Shrew.—*Ixodes granulatus, I. spinicoxalis.*

Tupaia tana tana Raffles, Large Tree Shrew.—*Haemaphysalis cornigera* (?).

Family Erinaceidae

Hylomys suillus suillus Müller, Short-tailed Shrew, or Lesser Gymnure.—*Ixodes granulatus.*

Family Soricidae

Crocidura orientalis Jentink, White-toothed Shrew.—*Ixodes granulatus, I. spinicoxalis.*

Order Chiroptera

Bat.—*Haemaphysalis toxopei.*

Order Primates

Family Hominidae

Homo sapiens Linnaeus.—*Amblyomma testudinarium, Rhipicephalus sanguineus.*

Family Hylobatidae

Hylobates syndactylus syndactylus (Raffles), Siamang.—*Haemaphysalis hylobatis.*

Family Lorisidae

Nycticebus coucang (Boddaert), Slow Loris.—*Haemaphysalis koningsbergeri.*

Order Carnivora

Family Mustelidae

Martes flavigula henrici (Schinz), Yellow-throated Marten.—*Amblyomma testudinarium, Haemaphysalis koningsbergeri, Ixodes spinicoxalis.*

Helictis orientalis (Horsfield), Ferret Badger.—*Haemaphysalis koningsbergeri.*

Arctonyx collaris hoevenii (Hubrecht), Hog-nosed Badger.—*Haemaphysalis hystricis.*

Mydaus javanensis javanensis (Leschenault), Teledu.—*Haemaphysalis koningsbergeri, Ixodes spinicoxalis.*

Family Canidae

Canis familiaris Linnaeus, Domestic Dog.—*Boophilus microplus, Haemaphysalis bispinosa, H. hystricis, H. papuana, Rhipicephalus haemaphysaloides haemaphysaloides, R. haemaphysaloides pilans, R. sanguineus.*

Family Viverridae

Paradoxurus hermaphroditus javanicus (Horsfield), Palm Civet, or Musang.—*Haemaphysalis koningsbergeri, Ixodes spinicoxalis.*

Family Felidae

Felis tigris Linnaeus, Tiger.—*Haemaphysalis koningsbergeri, Rhipicephalus haemaphysaloides haemaphysaloides, R. haemaphysaloides pilans.*

Felis pardus Linnaeus, Leopard, or Panther.—*Haemaphysalis koningsbergeri.*

Felis bengalensis javanensis Desmarest, Leopard Cat.—*Haemaphysalis koningsbergeri.*

Order Edentata, or Pholidota

Family Manidae

Manis javanica Desmarest, Pangolin, or Scaly Anteater.—*Amblyomma javanense.*

Order Rodentia

Family Sciuridae

Petaurista petaurista petaurista (Pallas), Large Red Flying Squirrel, or Giant Flying Squirrel.—*Haemaphysalis koningsbergeri.*

Ratufa bicolor bicolor (Sparrmann), Black Giant Squirrel.—*Haemaphysalis koningsbergeri.*

Callosciurus notatus notatus (Boddaert), Common Malay Squirrel, or Plantain Squirrel.—*Ixodes granulatus.*

Callosciurus notatus madurae (Thomas), Common Malay Squirrel, or Plantain Squirrel.—*Ixodes granulatus.*

Callosciurus nigrovittatus nigrovittatus (Horsfield), Black-striped Squirrel.—*Ixodes granulatus, I. spinicoxalis.*

Lariscus insignis javanus (Thomas and Wroughton), Striped Ground Squirrel.—*Ixodes granulatus.*

Family Muridae

Rattus rattus rattus (Linnaeus), Black Rat.—*Ixodes granulatus, Haemaphysalis koningsbergeri.*

Rattus rattus diardi (Jentink), Malaysian House Rat.—*Ixodes granulatus.*

Rattus rattus brevicaudatus Horst and de Raadt, Ricefield Rat, or Sawah Rat.—*Ixodes granulatus.*

Rattus rattus jalorensis (Bonhote), Malaysian Field Rat.—*Ixodes granulatus.*

Rattus concolor ephippium (Jentink), Little Burmese Rat.—*Ixodes granulatus.*

Rattus maxi Sody, Giant Rat.—*Ixodes granulatus.*

Rattus lepturus (Jentink), Long-tailed Rat.—*Ixodes granulatus, I. spinicoxalis.*

Rattus fulvescens bukit (Bonhote), Bonhote Rat.—*Ixodes spinicoxalis.*

Rattus fulvescens treubi Robinson and Kloss, Bonhote Rat.—*Ixodes granulatus.*

Rattus fulvescens temmincki Kloss, Bonhote Rat.—*Ixodes granulatus.*

Rattus bartelsi (Jentink), Bartels Rat.—*Ixodes granulatus.*

Pithecheir melanurus melanurus Cuvier, Red Tree Rat.—*Ixodes spinicoxalis.*

Order Perissodactyla

Family Rhinocerotidae

Rhinoceros sondaicus Desmarest, Javan, or One-horned Rhinoceros. —*Amblyomma testudinarium.*

Family Tapiridae

Tapirus indicus Desmarest, Malay Tapir.—*Amblyomma testudinarium.*

Family Equidae

Equus caballus Linnaeus, Domestic Horse.—*Amblyomma babirussae, Boophilus microplus, Haemaphysalis bispinosa, H. hystricis, H. papuana, Rhipicephalus haemaphysaloides pilans.*

Order Artiodactyla

Family Suidae

Sus cristatus cristatus Wagner, Wild Pig.—*Amblyomma testudinarium, Rhipicephalus haemaphysaloides pilans.*

Sus cristatus vittatus Boie, Wild Pig.—*Amblyomma testudinarium, Rhipicephalus haemaphysaloides pilans.*

Sus verrucosus Müller and Schlegel, Java Pig.—*Amblyomma testudinarium.*

Sus barbatus Müller, Bearded Pig.—*Amblyomma testudinarium.*

Sus celebensis Müller and Schlegel, Celebes Pig.—*Amblyomma babirussae, A. cyprium, Haemaphysalis hystricis.*

Sus scrofa Linnaeus, Domestic Pig.—*Amblyomma testudinarium, Boophilus microplus, Dermacentor auratus, Haemaphysalis bispinosa, H. hystricis, H. papuana, Rhipicephalus haemaphysaloides haemaphysaloides.*

Babirussa babyrussa (Linnaeus), Babirusa.—*Amblyomma babirussae.*

Family Tragulidae

Tragulus kanchil kanchil (Raffles), Smaller Mouse Deer, or Pelandok.—*Haemaphysalis traguli.*

Family Cervidae

Cervus unicolor equinus Cuvier, Sambar, or Rusa.—*Boophilus microplus.*

Cervus unicolor russa Müller and Schlegel, Sambar, or Rusa.—*Boophilus microplus.*

Cervus sp.—*Amblyomma testudinarium.*
Deer.—*Boophilus microplus, Haemaphysalis bispinosa.*

Family Bovidae

Bos sondaicus sondaicus Schlegel and Müller, Banteng, or Wild Ox. —*Amblyomma testudinarium, Haemaphysalis cornigera, H. papuana.*

Bos bubalis bubalis Linnaeus, Indian, or Water Buffalo.—*Amblyomma babirussae, A. cyprium cyprium, A. testudinarium, Boophilus microplus, Haemaphysalis hystricis, H. papuana, H. wellingtoni, Rhipicephalus haemaphysaloides haemaphysaloides, R. haemaphysaloides pilans, R. sanguineus.*

Bos taurus Linnaeus, Domestic Cattle.—*Amblyomma babirussae, A. testudinarium, Boophilus microplus, Haemaphysalis bispinosa, H. cornigera, H. hystricis, H. papuana, Rhipicephalus haemaphysaloides haemaphysaloides, R. haemaphysaloides pilans, R. sanguineus.*

Capra hircus Linnaeus, Domestic Goat.—*Amblyomma testudinarium, Boophilus microplus, Haemaphysalis bispinosa, Rhipicephalus haemaphysaloides haemaphysaloides, R. haemaphysaloides pilans, R. sanguineus.*

Ovis aries Linnaeus, Domestic Sheep.—*Haemaphysalis bispinosa, Rhipicephalus haemaphysaloides pilans.*

KEY TO GENERA

Males

1. Ventral side mostly covered by seven hardened, non-salient plates, the anal plate limited by a distinct groove curved in front of the anus and extended to the hind margin. Scutum inornate, without festoons. Palps elongate. No eyes. *Ixodes*

   Posterior groove on ventral side either curved behind the anus or indistinct. Ventral side either without extensive plates or partly covered by salient plates 2

2. Eyes absent. Scutum with festoons. Ventral side without plates 3

   Eyes present 4

3. Palps short and broad, at most as long as basis capituli; second segment more or less angular at sides. Scutum inornate. *Haemaphysalis*

Palps long and slender; second segment not angular at sides. Scutum ornate or inornate .... *Aponomma*

4. Palps long and slender; second segment not angular at sides. Ventral side without extensive or salient plates. Basis capituli not angular at sides. Scutum with festoons, ornate or inornate .... *Amblyomma*

   Palps short and broad, at most as long as basis capituli 5

5. Basis capituli rectangular, not angular at sides. Ventral side without salient plates. Scutum with festoons, ornate in East Indian species .... *Dermacentor*

   Basis capituli hexagonal, with angular sides. Ventral side partly covered by four plates, often salient at the hind margins. Scutum inornate 6

6. Scutum with festoons. Post-anal groove distinct. Coxae I with two long spurs .... *Rhipicephalus*

   Scutum without festoons. Post-anal groove indistinct. Coxae I with two very short spurs .... *Boophilus*

Females

1. Ventral side posteriorly with a distinct groove curved in front of the anus. Scutum inornate. Palps elongate. No eyes. *Ixodes*

   Ventral side posteriorly with a groove curved behind the anus or the groove indistinct 2

2. Eyes absent 3

   Eyes present 4

3. Palps short and broad, at most as long as basis capituli; second segment angular or produced at sides. Scutum inornate. *Haemaphysalis*

   Palps long and slender; second segment not angular at sides. Scutum ornate or inornate .... *Aponomma*

4. Palps long and slender. Basis capituli not angular at sides. Scutum ornate or inornate .... *Amblyomma*

   Palps short and broad 5

5. Basis capituli rectangular, not angular at sides. Scutum ornate in East Indian species .... *Dermacentor*

   Basis capituli hexagonal, with angular sides. Scutum inornate 6

6. Post-anal groove distinct. Second and third segments of palps not unusually short and not angular at outer base. Coxae I with two long spurs .... *Rhipicephalus*

Post-anal groove indistinct. Second and third segments of palps very short, slightly angular at outer base. Coxae I with two very short, blunt spurs .... *Boophilus*

Genus *Ixodes* Latreille, 1795

Oudemans (1925, Ent. Ber. Nederl. Ent. Ver., **7**, pt. 146, p. 32) described a single male from Amboina, Moluccas, as *Eschatocephalus ropsteini.* Schulze (1935, Zeitschr. Morph. Oekol. Tiere, **30**, pt. **1**, pp. 27, 28, fig. 28) corrected the name to *kopsteini,* regarded it as an *Ixodes* and created the new subgenus *Lepidixodes* for it. The palps are club-shaped and primitive; the hypostome is devoid of teeth; the spiracles are laterally placed and near the middle of the body length; body, capitulum and legs are covered with scale-like structures; the claws are very thick; and the body is very hairy. All these characters are primitive and unlike those of the ticks; this form probably represents a special type of mite, and I see no reason for regarding it as a tick, let alone an *Ixodes.*

Key to Species of *Ixodes*[3]

Males

Coxa I with two short spurs, internal slightly longer than external. Punctations medium and uniformly distributed. Cornua short and blunt .... *I. granulatus*

Coxa I with two unequal spurs, internal very long, several times longer than external. Punctations large and restricted to lateral borders, region behind pseudoscutum and posterior border. Cornua absent .... *I. spinicoxalis*

Females

Hypostome with 3:3 dentition. Cornua absent. Auriculae small. Coxa I with two short spurs, internal twice as long as external .... *I. granulatus*

Hypostome with 4:4 dentition at tip, then 3:3. Cornua short and blunt. Large auriculae as flat retrograde prominences. Coxa I with two unequal spurs, internal very long, several times as long as external .... *I. spinicoxalis*

Ixodes praematurus Schulze.

Ixodes praematurus Schulze, 1935, Zeitschr. Morph. Oekol. Tiere, **30**, pt. 1, pp. 6, 8, 34, fig. 9 (n, Timor, off *Zosterops* sp., a Timaliide, *Geocirla* [*sic*] = *Geokichla;* holotype Z. M. Berl.) ; 1941, *Op. cit.,* **37**, pt. 3, pp. 497, 499, fig. 4.

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[3] *I. praematurus* is known only from the nymphal stage.

Schulze described this species from several nymphs taken on Moetis Mountains in Timor by G. Stein in 1932. He states that he saw a tiny plate at the hypothetical point of union of the genital grooves, and since this structure lies in the position of the future genital orifice, he believes that it might be the primitive genital slit which later gives rise to the typical form found in the sexually mature adult. *I. praematurus* differs from *I. ricinus* in possessing yellowish-brown legs, an acuminate tarsus I and a more strongly narrowed scutum. I did not see this species, and I do not know of any other species with which this nymph can be correlated. Further specimens may afford a better understanding of its affinities.

Ixodes granulatus Supino.

Ixodes granulatus Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 232 (♂, ♀, Bhamo, Mooleyis, Tarrawaddy [Lower Burma], Terinzo [Upper Burma], off *"Sciurus gordoni"* = *Callosciurus erythraeus gordoni, Felis tigris, "Sciurus rufigenis"* = *Dremomys rufigenis, "Sciurus striatus"* = *Callosciurus quinquestriatus;* cotypes Genoa M.) ; 1897, *Op. cit.,* (2) **3**, pt. 2, pp. 248–249, Pl. 12, figs. 5–6. Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 164–165; 1902, Arch. de Parasit., **6,** pt. 1, p. 125 (supplementary description based on types; 4 ♀, male of Supino is unengorged female). Nuttall and Warburton, 1911, Ticks, **1,** pt. 2, *Ixodes,* pp. 285, 291–292 (status doubtful). Nuttall, 1916, Parasitology, **8,** pt. 3, pp. 315–316, fig. 17 (examined types; 3 ♀, Pashok, Darjeeling District, India, off *"Epimys rufescens"* = *Rattus rufescens*). Warburton, 1926, Treubia, **8,** pts. 3–4, p. 280 (♀, Muaro Sako, Sumatra's west coast). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 145, map 5; 1932, Veeartsenijk. Meded., No. **79,** pp. 30–31, 36, figs. 47–48, map 5 (2 ♂, Java, off *Rattus concolor ephippium, Rattus rattus diardi;* ♀, Java and Bawean Island, off *"Mus rattus"* = *Rattus rattus, Rattus concolor ephippium*) ; 1933, Zeitschr. f. Parasitenk., **5,** pt. 2, pp. 410–411, fig. 3 (2 ♂, ♀, Mountain near Tjibodas, Java, off *Rattus concolor ephippium* and *Rattus rattus diardi*). Schulze, 1934, *Op. cit.,* **7,** pt. 2, pp. 169–170 (♂, ♀, n, l, Java, off *"Rattus rattus ro-*

quei" = *Rattus rattus jalorensis, Rattus rattus brevicaudatus, "Rattus bukit treubi"* = *Rattus fulvescens treubi, "Rattus bukit temmincki"* = *Rattus fulvescens temmincki, Rattus bartelsi, Rattus maxi, Rattus concolor ephippium, Rattus lepturus, "Sciurus notatus notatus"* = *Callosciurus notatus notatus, "Sciurus nigrivittatus nigrivittatus"* = *Callosciurus nigrovittatus nigrovittatus, "Sciurus notatus madurae"* = *Callosciurus notatus madurae, Lariscus insignis javanicus* [*sic*], *Tupaia javanica occidentalis, Crocidura orientalis, Hylomys suillus suillus*); 1939, *Op. cit.*, **10**, pt. 6, p. 724 (n, Mt. Victoria, Pakokku-Chin Hills, off *Crocidura* sp.). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, p. 22, Pl. 7 (in part: only the male cited from Krijgsman and Ponto, 1932; female = *Ixodes kempi* Nuttall).

Ixodes (*Ixodes*) *granulatus* Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 11, 20–21 (Java, off *"Tupaia ferruginea"* = *Tupaia glis hypochrysa*).

[*non Ixodes granulatus* Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 236–237 (♀, Pashok in Darjeeling District, off *"Epimys rufescens"* = *Rattus rufescens;* ♀, Kohima in Naga Hills District, Assam, off squirrel) = *Ixodes kempi* Nuttall].

In 1928 Sharif briefly described several female specimens from India as *I. granulatus,* without figuring them. He also examined the type material of *Ixodes kempi* Nuttall, 1913, and regarded it as synonymous with *Ixodes granulatus.* It is likely that Sharif only had specimens of *kempi* and incorrectly determined them as *granulatus,* for his description fits *kempi* more closely than it does *granulatus.* I saw specimens of *granulatus* from Burma which agree with the descriptions and figures given by Neumann in 1902 and Nuttall in 1916, both of whom saw the type specimens. I also saw six females and one male of *I. kempi,* in the Museum of Comparative Zoölogy, from Phong Saly and Muong Yo, Indochina, taken off *Callosciurus imitator* and *Ratufa gigantea* by R. Wheeler in May, 1929; the male was copulating with a female at the time it was collected and is preserved in this condition. After comparing these two species, I am convinced that *kempi* is a valid species and that it is distinct from *granulatus.* Toumanoff recorded the female of *granulatus* from Indochina, but his description and figures also resemble *kempi* more than they do *granulatus.*

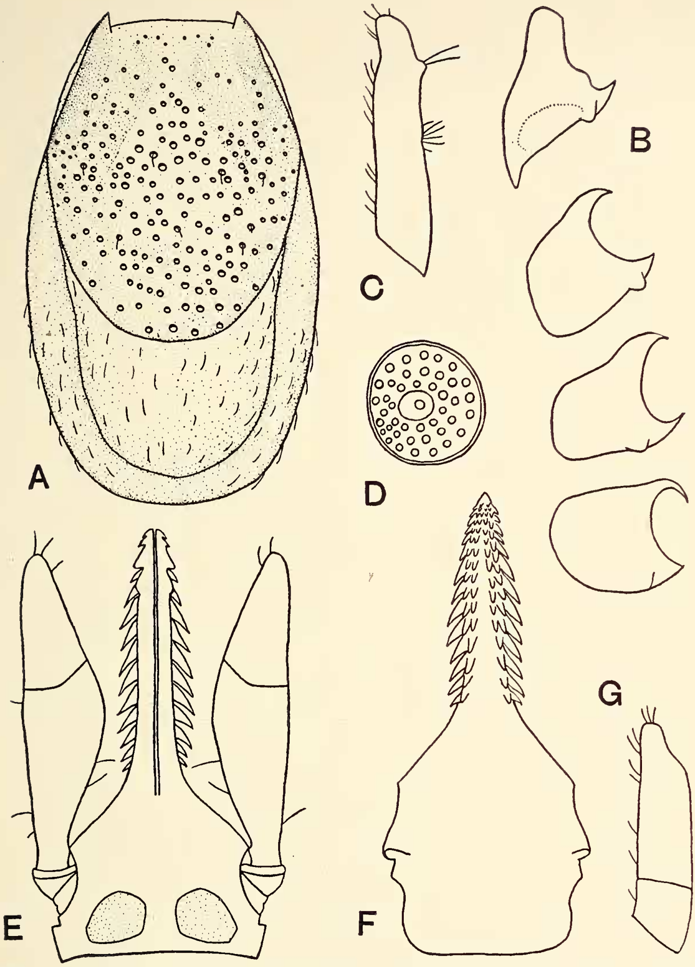


Fig. 2. *Ixodes granulatus* Supino, female: A, body in dorsal view; B, coxae I–IV; C, tarsus I; D, spiracle; E. capitulum in dorsal view; F, same in ventral view; G, tarsus IV.

Specimens not being available from the East Indies, the following description is based upon females from Burma.

Female (Fig. 2A–G). Two specimens respectively 1.8 and 1.7 mm. long and 0.96 and 1.05 mm. wide, exclusive of capitulum. Body elongate oval, much longer than wide. Scutum glossy brown, finely granulated, oval, covering about two-thirds of entire body, widest at mid-length, 1.19 mm. long and 0.77 mm. wide, with very few, scattered hairs; scapulae very pointed; punctations large, uniformly distributed on posterior half; cervical grooves superficial, scarcely visible, beginning some distance behind border of emargination and diverging posteriorly, not reaching postero-lateral borders of scutum; a lateral ridge present on each side, beginning at inner margin of scapula, but not reaching postero-lateral border; a depressed region between lateral ridge and cervical groove on each side, wide anteriorly and narrow posteriorly. Abdomen yellow, with numerous, long, white hairs; marginal groove complete, deep and conspicuously covered with long, white hairs; genital opening opposite coxa IV; anal opening opposite posterior border of spiracles; spiracles nearly circular, with large goblets; genital groove diverging widely, not reaching posterior margin of body; anal groove an inverted U. Legs long, fairly slender, brown, finely granulated, with numerous, long, white hairs; tarsi long, slender, narrowed abruptly before end, then gradually tapering to tip; pulvillus nearly as long as claws; coxa I with two short spurs, internal long and sharp, external short and blunt; coxae II–III with a short, external spur; coxa IV with an extremely short, inconspicuous spur, scarcely visible. Capitulum 0.728 mm. long; basis nearly triangular, without cornua, posterior margin nearly straight; porose areas large, oval, shallow, their distance apart equal to about one-half their diameter; ventrally basis broad, rounded posteriorly, with small auriculae; palps long, slender, widest near mid-length; slightly flattened on inner lateral border; article one apparent as a small protrusion; article two slightly longer than three; hypostome long, slender, pointed; dentition 3 : 3, with ten to eleven teeth per file.

Male. Not seen, but described by Krijgsman and Ponto (1933).

Nymph and Larva. Described by Schulze (1934).

Distribution and Hosts. Known from Burma, India and East Indies. No specimens were seen from Indonesia, but there are records from Java (Neumann, 1911; Krijgsman and Ponto, 1932; Schulze, 1934), Sumatra (Warburton, 1926) and Bawean Island (Krijgsman and Ponto, 1932). Specimens were seen at the Rocky

Mountain Laboratory from the Philippine Islands (Mt. Data, Mountain Province, Luzon, off *Rattus* sp.), Assam (Ledo), Manipur (Imphal), and Burma (Myitkyina), off *Callosciurus erythraeus nagarum, Tupaia belangeri versurae, Callosciurus quinquestriatus quinquestriatus, Rattus rattus sladeni, Urocissa erythrorhyncha magnirostris, Rattus manipulus,* mongoose and *Rattus* sp.

Ixodes spinicoxalis Neumann.

> *Ixodes spinicoxalis* Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 111, 123–124, fig. 6 (4 ♀, Sumatra, off "*Martes flavigula*" = *Martes flavigula henrici;* holotype in Brit. M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, (1901), p. 402. Nuttall and Warburton, 1911, Ticks, **1,** pt. 2, *Ixodes,* pp. 139, 171–172, figs. 165–166 (based on types). Warburton, 1926, Treubia, **8,** pts. 3–4, p. 280 (♀, Andalos (Tandjung) Sumatra's west coast, off *Martes flavigula henrici*). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 145, map 5; 1932, Veeartsenijk. Meded., No. **79,** pp. 29–30, 36, fig. 46, map 5 (♀, Java, off *Helictis orientalis*). Schulze, 1934, Zeitschr. f. Parasitenk., **7,** pt. 2, pp. 170–171, fig. 2 (♂, ♀, n, l, Tjiboeni, Mt. Lawoe, Mt. Tjareme, Pangrango, Java, off *Paradoxurus hermaphroditus javanicus, Crocidura orientalis* subsp., "*Sciurus nigrivittatus nigrivittatus*" = *Callosciurus nigrovittatus nigrovittatus, Tupaia javanica occidentalis, Rattus lepturus,* "*Pithecheirus melanurus*" = *Pithecheir melanurus melanurus* and "*Rattus bukit* subsp." = *Rattus fulvescens bukit*); 1939, *Op cit.,* **10,** pt. 6, p. 723.
>
> ? *Ixodes spinicoxalis* Yakimov and Kohl-Yakimov, 1910, Arch. de Parasit., **14,** p. 417 (Caucasia).
>
> *Ixodes (Ixodes) spinicoxalis* Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 10, 13.

Female (Fig. 3A–G). Single, unengorged specimen 2.85 mm. long and 1.9 mm. wide, exclusive of capitulum. Body elongate oval, widest at level of spiracles. Scutum oval, with rounded borders, glossy, brown-maroon, with sides slightly darker than central portion; three specimens respectively 1.6, 1.5, and 1.6 mm. long and 1.4, 1.6 and 1.5 mm. wide; large to medium, deep, closely set punctations restricted to outer portions of scutum; central portion depressed, slightly rugose, with punctations very small or absent; few, thin, white hairs; cervical grooves weak, superficial, scarcely visible, be-

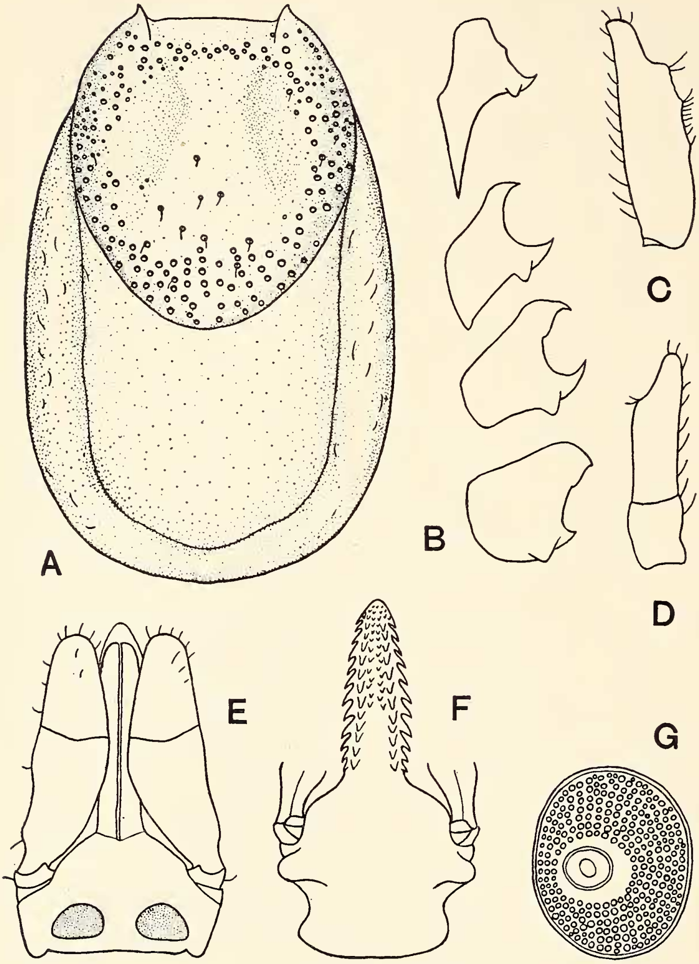


Fig. 3. *Ixodes spinicoxalis* Neumann, female: A, body in dorsal view; B, coxae I–IV; C, tarsus I; D, tarsus IV; E, capitulum in dorsal view; F, same in ventral view; G, spiracle.

ginning some distance behind emargination and extending to region of large, posterior punctations; no lateral ridges. Abdomen yellow, with marginal groove deep, conspicuous and complete; ventral surface yellow, with long and uniformly distributed hairs; genital opening opposite coxa IV; anal opening located very far posteriorly; spiracles large, white, nearly circular, with numerous, small goblets; genital grooves deep, divergent, extending to posterior margin of body; anal groove deep, forming an inverted U. Legs long, slender, reddish-brown, with distal portion of each joint, except last, yellowish-white, giving leg appearance of being banded; tarsus I very long, slender, tapering abruptly near tip; pulvillus nearly as long as claws; coxae long, nearly touching in unengorged specimen; coxa I with very long, slender, pointed, internal spur, nearly reaching posterior border of coxa II, and very short, external spur; coxae II–III with short, external spur and faint suggestion of an internal spur; coxa IV with single, short, external spur. Capitulum 0.94 to 1.05 mm. long in three specimens; basis darker than palps, broader than long, sub-triangular, with short, blunt cornua; porose areas large, oval to rounded; palps long, flat, widest at mid-length; article one visible as slight protrusion; article two slightly longer than article three; ventral auriculae large, in form of flat, retrograde prominence; hypostome long, narrow, spear-shaped, with 4 : 4 dentition at anterior tip and 3 : 3 in posterior part.

Male, Nymph and Larva. Not seen, but described by Schulze (1934).

Distribution and Hosts. Known from Sumatra (Neumann, 1899) and Java (Krijgsman and Ponto, 1932; Schulze, 1934). The record from Caucasia (Yakimov and Kohl-Yakimov, 1910) is probably an error in determination. Three females were seen at the Museum of Comparative Zoölogy from Tjibodas, Mt. Gede, Java, collected September 12, 1909, by Palmer and Bryant off *Mydaus javanensis javanensis.*

Genus *Haemaphysalis* C. L. Koch, 1844

Key to Species of *Haemaphysalis*

Males

1. Coxa IV with long, slender, internal spur and shorter, external spur. Coxa I with long spur. Scutum fusiform. Punctations numerous, unequal and uniformly distributed. Article three with sharp, lateral spur. Article two very salient

laterally .... *H. cornigera*
Coxa IV with only one spur 2
2. No lateral grooves present 3
Short or long lateral grooves present 4
3. Article two with lobe-like projection on antero-internal border. Article three with distinct, dorsal, retrograde spur. Hypostome with 4:4 dentition. Scutum elongate-oval. Punctations medium and irregularly distributed .... *H. hystricis*
Article two without lobe-like projection. Article three with only slight indication of dorsal spur. Hypostome with 5:5 dentition. Scutum broad-oval. Punctations extremely fine and uniformly distributed .... *H. toxopei*
4. Lateral groove very short. Cornua strongly developed and extending slightly beyond anterior border of scutum. Scutum elongate-oval. Punctations numerous, superficial and regularly distributed. Coxae I–IV with single, lobe-like spur. Article two strongly salient laterally .... *H. traguli*
Lateral groove long 5
5. Palpal article three with distinct, dorsal, retrograde spur 6
Palpal article three without such spur, but posterior border may protrude slightly 8
6. Article three with distinct, dorsal, retrograde spur at inner angle. Article two very salient laterally. Scutum broadest posteriorly. Punctations few, unequal and sparsely distributed. Coxae I–IV with single, short spur. *H. wellingtoni*
Article three with dorsal, retrograde spur at middle of posterior border 7
7. Coxa I with short, blunt spur. Palpal article two strongly salient laterally. Scutum elongate-oval. Punctations coarse, uniform and closely set .... *H. hylobatis*
Coxa I with long, pointed spur. Palpal article two only slightly salient laterally. Scutum broad-oval. Punctations medium and uniformly distributed .... *H. bispinosa*
8. Scutum very elongate. Punctations medium, numerous and uniformly distributed. Article two very strongly salient laterally, with strong, lobe-like projection on antero-internal border. Coxa I with short, blunt spur .... *H. koningsbergeri*
Scutum elongate-oval. Punctations medium, less numerous and irregularly distributed. Several raised tracts present making surface very irregular. Palpal article two only slightly

salient laterally, with weak lobe-like projection on antero-internal border. Coxa I with short, sharp spur.
H. papuana

Females

1. Cervical grooves well-marked, sinuous and reaching posterior margin of scutum. Scutum circular. Punctations numerous and shallow. Cornua slight .... *H. toxopei*
Cervical grooves not reaching posterior margin of scutum 2
2. Palpal article three with distinct, dorsal, retrograde spur, more or less erect 3
Palpal article three without such spur, but posterior border may protrude slightly 6
3. Dorsal spur at inner angle of posterior border. Palpal article two very salient laterally. Basis about three times as broad as long. Scutum slightly longer than broad ... *H. wellingtoni*
Dorsal spur at middle of posterior border 4
4. Coxa I with short, blunt spur. Palpal article two strongly salient laterally, with distinct lobe-like projection at antero-internal border. Basis about three times as broad as long. Cornua weak. Scutum nearly circular. Punctations coarse and uniformly distributed .... *H. hylobatis*
Coxa I with medium, pointed spur 5
5. Cervical grooves broad, shallow and nearly parallel. Spiracles circular, with distinct process. Punctations unequal and irregularly distributed .... *H. hystricis*
Cervical grooves well-marked, deep and converging, then shallow and diverging. Spiracles oval, without process. Punctations equal and more or less uniformly distributed.
H. bispinosa
6. Coxae II–III with broad, ridge-like spurs. Scutum slightly broader than long. Punctations equal and uniformly distributed. Basis about three times as broad as long. Cornua large, broad and blunt. Articles two and three salient laterally .... *H. traguli*
Coxae II–III with short spurs, about as wide as long 7
7. Scutum much longer than wide. Punctations equal and uniformly distributed. Basis about three times as broad as long. Palpal article two very salient laterally, with lobe-like projection on antero-internal border.
H. koningsbergeri

Scutum slightly wider than long 8

8. Palpal article two very salient laterally, posterior margin wavy and strong, lobe-like projection on antero-internal border. Basis about three times as broad as long. Coxa I with long, pointed spur .... *H. cornigera*

Palpal article two only slightly salient laterally, posterior margin nearly straight, weak lobe-like projection on antero-internal border. Basis about three times as broad as long. Coxa I with short, pointed spur .... *H. papuana*

Haemaphysalis bispinosa Neumann.

Haemaphysalis bispinosa Neumann, 1897, Mém. Soc. Zool. France, **10,** pp. 341–342, 358, figs. 7–8 (1 ♀, Ramnad, India; holotype described from E. Simon Coll., probably now at Paris M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 458, 459. Warburton, 1907, Journ. Econ. Biol., **2,** pt. 3, p. 94; 1907, Imp. Dept. Agric., India, Bull. No. **6,** pp. 1, 7, 8, 9, 11, 12, fig. 9 (Bombay and Poona, off horse and cattle); 1908, Proc. Cambridge Philos. Soc., **14,** pt. 5, pp. 517–518, figs. 9–10 (♂, ♀, India and Ceylon). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 148. Warburton, 1910, Parasitology, **3,** pt. 4, p. 396 (India, off dog, tiger and *Macaca*). Patton and Cragg, 1913, Textbook Medical Ent., p. 648, Pl. 73, fig. 11, Pl. 81, figs. 5–6. Nuttall and Warburton, 1915, Ticks, **1,** pt. 3, *Haemaphysalis,* pp. 354, 360, 361, 426–433, figs. 358–362 (♂, ♀, n, l, extensive distribution and host records). Nieschulz, 1924, Nederl. Tijdschr. v. Diergeneesk., **51,** p. 195 (Kota-Radja in Atjeh, Sumatra, off cattle). Myers, 1924, New Zealand Dept. Agric., Bull. No. **116,** pp. 1–105, figs. 1–17 (life history, biology, distribution, hosts and control). Fielding, 1926, Comm. Austral. Service Publ. (Trop. Div.) No. **9,** pp. 60–62, fig. 23. Ogura and Takada, 1927, Journ. College Agric., Hokkaido Imp. Univ., **18,** pt. 4, pp. 204–205, Pl. 14, figs. 1–6 (♂, ♀, Honshu, Hokkaido, Kyushu, Chosen, off cattle, horses, hares). Sharif, 1928, Records Indian Mus., **30,** pt. 3, pp. 255–258, fig. 12 (extensive host list and distribution). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 142, map 3; 1932, Veeartsenijk. Meded., No. **79,** pp. 12–13, 33, 34, figs. 10–11, map 3 (♂, ♀, Sumatra, Java, Soembawa, Karimoendjowo, Celebes, off cow, horse, buffalo, deer). Roberts, 1934, Queensland Agric. Journ., **42**, pt. 2, p. 120, Pl. 28, figs. 1–2 (Australia). Sugimoto, 1936, Journ. Soc. Trop. Agric., Formosa, **8**, pt. 4, p. 336 (Formosa). Schulze, 1936, Zeitschr. Morph. Oekol. Tiere, **32**, pt. 2, p. 197, fig. 10*a* (n, morphological). Sharif, 1938, Indian Journ. Vet. Sci. and Anim. Husb., **8**, pt. 4, pp. 355, 356, 361, 364 (disease transmission). Strickland, 1939, Indian Journ. Med. Res., **27**, pt. 1, pp. 251–252 (Nowgong, off man). Schulze, 1939, Zeitschr. f. Parasitenk., **10**, pt. 6, p. 728 (Burma). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 41–43, 87, 90, Pls. 20–21, 44–45 (♂, ♀, Indochina, off Sambar deer, "*Cervus aristotelis*" = *Cervus unicolor*, tiger, wild cat, panther, roe deer, bear, dog, pig and man). Finnegan, 1945, Brit. Mus., Econ. Series, No. **16**, p. 44, fig. 16.

Haemaphysalis neumanni Dönitz, 1905, Sitz.-Ber. Gesellsch. Naturf. Fr. Berlin, pt. 4, pp. 127–129, 134, Pl., figs. 4–6 (♂, ♀, Japan, off horse, cattle, and dog; location of types not given). Warburton, 1908, Proc. Cambridge Philos. Soc. **14**, pt. 5, p. 519. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 154. Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 106, 107, 109 (♂, ♀, Japan, Ceylon, off *Equus caballus*, *Bos taurus* and *Canis familiaris*).

? *Haemaphysalis neumanni* Galli-Valerio, 1909, Centralbl. f. Bakteriol. u. Parasit., 1 Abt., Orig., **51**, pt. 5. p. 539 (Ceylon, off *Canis aureus*). Yakimov and Kohl-Yakimov, 1910, Arch. de Parasit., **14**, p. 418 (6 ♀, China, Primorsk Government, E. Siberia, off cattle).

Haemaphysalis birmaniae Neumann, 1911, [in part, *nec* Supino, 1897] Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 109.

? *Haemaphysalis bispinosa* Olenev, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, p. 133 (Vladivostok). Pomerantzev, 1946, Inst. Zool. Acad. Sci. URSS, Tabl. Analyt. Faune URSS, **26**, pp. 13, 14 (Russia).

Haemaphysalis renschi Schulze, 1933, Arch. f. Hydrobiol., Suppl. Bd. **12**, pp. 490, 492 (Flores, in key only); 1936, Zeitschr. f. Parasitenk., **8**, pt. 5, pp. 524–526, fig. 6 (2 ♂, Rana Mêsé, Flores; holotype Z. M. Berlin).

Numerous males of *bispinosa* from Roeteng, Flores Island, in the Kraneveld collection agree in all respects with the illustrations and description of *renschi* given by Schulze for two males from the same locality. These are definitely the same species, and I regard *H. renschi* Schulze as a synonym of *H. bispinosa* Neumann.

Male (Fig. 4A–F). Twenty-five specimens range from 2.1 to 1.68 mm. long by 1.4 to 1.26 mm. wide, exclusive of capitulum; average 1.88 mm. long by 1.37 mm. wide. Body long, oval and widest at mid-length, yellow to brown depending on degree of hardening; some with brown, hardened markings in intervals between festoons; punctations medium, very numerous and uniformly distributed; cervical grooves short and inconspicuous; lateral grooves beginning near mid-length and passing posteriorly to region of first festoon; festoons distinct and longer than wide; body ventrally yellow to brown, with many, minute punctations and with very small, white hairs; genital opening opposite coxa II; anal opening opposite posterior portion of spiracle; spiracle oval and slightly narrowed anteriorly, with numerous, very small goblets. Legs long and thick, with many, long, white hairs; coxa I with single, long, pointed spur; coxae II–IV with a very short spur; tarsi short, tapering gradually; pulvillus almost as long as claws. Capitulum 0.42 mm. long, longer than wide; basis rectangular, slightly wider than long, with large, distinct cornua; palps small and slightly salient; articles two and three subequal; sharp, retrograde, dorsal spur and long, sharp, ventral spur on middle of posterior border of article three; hypostome very short; dentition 4:4, with approximately seven to eight teeth per file.

Female (Fig. 4G–L). Twenty-five specimens range from 2.25 to 1.68 mm. long by 1.5 to 1.26 mm. wide, exclusive of capitulum; average 2.18 mm. long by 1.48 mm. wide; fully engorged specimen 7.8 mm. long by 6.0 mm. wide. Scutum 0.90 mm. long by 0.96 mm. wide, yellow and nearly circular; cervical grooves anteriorly fairly deep and slightly convergent, posteriorly shallow and divergent nearly reaching postero-lateral border; punctations medium, uniformly distributed and very numerous; long marginal groove beginning behind scutum and including first festoon; festoons about as wide as long. Abdomen very finely punctate ventrally, with short, white hairs; genital opening opposite anterior border of coxa III; anal opening opposite posterior border of spiracles; spiracles similar to male; genital grooves diverging gradually; anal grooves fusing anteriorly with posterior portion of genital grooves. Coxae

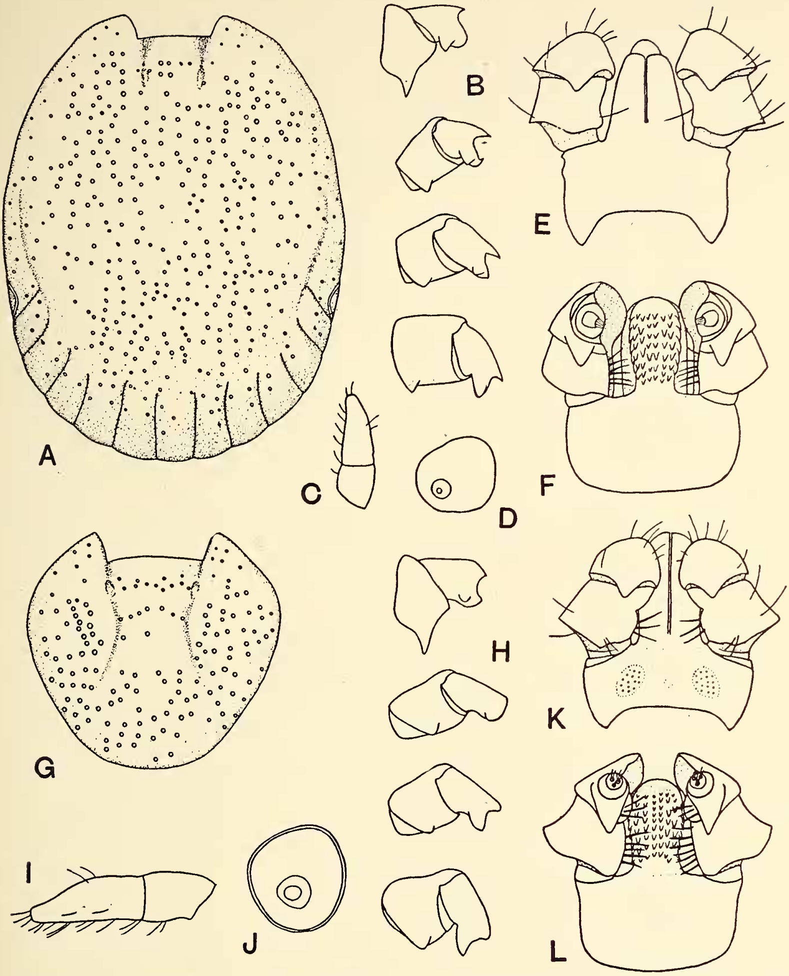


Fig. 4. *Haemaphysalis bispinosa* Neumann. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, spiracle; E, capitulum in dorsal view; F, same in ventral view. G–L, female: G, scutum; H, coxae I–IV; I, tarsus IV; J, spiracle; K, capitulum in dorsal view; L, same in ventral view.

similar to male; tarsi long and tapering gradually; pulvillus long and narrow, but slightly shorter than claws. Capitulum 0.54 mm. long; basis much wider than in male; porose areas large, rounded and widely separated; hypostome short; dentition 4:4, with approximately eight to nine teeth per file.

Distribution and Hosts. Known from India, Burma, Andaman Islands, Federated Malay States, Ceylon, Japan, Borneo, Australia, New Zealand, East Indies, Formosa, Indochina, East Africa (introduced from India), Siberia (?) and China. In the East Indies it has been recorded from Sumatra (Nieschulz, 1924; Krijgsman and Ponto, 1931, 1932), Java, Soembawa, Karimoendjowo Island, Celebes (Krijgsman and Ponto, 1931, 1932) and Flores (Schulze, 1936). Numerous specimens were seen in the Kraneveld collection from Sumatra (Lhokseumawe, off cow and goat; Padangsidimpoean, off cow; Koetaradja, off cow), Java (Madioen, off dog), Bali (Singaradja, off cow, horse and sheep), Flores (Roeteng, off buffalo, cow and horse) and Soela Island (off domestic pig). Specimens were also seen in the Museum of Comparative Zoölogy from Australia and China and in the Rocky Mountain Laboratory from China, Japan, New Caledonia, Australia, Burma, Assam and India off a great variety of hosts.

Haemaphysalis cornigera Neumann.

Haemaphysalis cornigera Neumann, 1897, Mém. Soc. Zool. France, **10**, pp. 350–352, 359, figs. 16–17 (2 ♂, 1 ♀, Singapore; 2 ♂, Borneo, off deer; 1 ♂, Sumatra, off *Bos bubalis* [*nec* ♂ from Judea]; cotypes described from E. Simon Coll., now probably at Paris M.; R. Blanchard Coll.; and Oudemans Coll., now at Leiden M.); 1910, Ann. Sci. Nat. Zool., **9**, pp. 174–175. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 458. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 150, fig. 185. Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 106, 107, 112–113, figs. 57–58. Nuttall and Warburton, 1915, Ticks, **1**, pt. 3, *Haemaphysalis*, pp. 354, 358, 500–504, figs. 441–445 (♂, ♀, Federated Malay States, British North Borneo, India, off wild pig, tiger, Sambar deer, water buffalo, buffalo). Larrousse, 1925, Ann. Parasit. Hum. et Comp., **3**, pt. 3, pp. 301–302, fig. 1 (4 ♂, 2 ♀, Nhatrang, Annam, off "*Cervulus muntjac*" ? = *Muntiacus muntjak*). Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 270–272 (♂, ♀, East Bengal, Assam, off Sambar deer and dog). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 142, map 3; 1932, Veeartsenijk. Meded., No. **79**, pp. 13–14, 33, 34, figs. 12–13, map 3 (♂, ♀, Java, Borneo, Sumatra, Bali, Soemba, Soembawa, Karimoendjowo Island, off cow and buffalo). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 45–46, 86, 91, Pls. 22, 24–26, 44–45 (♂, ♀, Cochin China and Cambodge, off Sambar deer, wild cattle, civet).

Haemaphysalis proxima Warburton and Nuttall, 1909, Parasitology, **2**, pts. 1–2, pp. 61–62, fig. 6 (1 ♀, Sumatra, off *Bos bubalis;* type in Brit. Mus.).

Haemaphysalis spiniceps Warburton and Nuttall, 1909, *Op. cit.,* **2**, pts. 1–2, pp. 68–69, fig. 15 (1 ♂, Malay States; type in London Sch. Trop. Med.).

? *Haemaphysalis spinigera* Oudemans, 1925, [*nec* Neumann, 1897], Ent. Ber. Nederl. Ent. Ver., **7**, pt. 146, p. 32.

? *Haemaphysalis cornigera* Warburton, 1926, Treubia, **8**, pts. 3–4, p. 280 (n, Suban Ajam, Benkoelen, Sumatra, off "*Tana tana*" = *Tupaia tana tana*). Oudemans, 1927, Zool. Meded., Leyden, **10**, pt. 4, pp. 223–228, figs. 80–94 (n, 1, Amboina, off *Viverra* sp).

Haemaphysalis cornigera var. *taiwana* Sugimoto, 1936, Journ. Soc. Trop. Agric., Formosa, **8**, pt. 4, pp. 337– 339, Pl. 1, figs. 1–12 (♂, ♀, Karenko, Naimonsho and Taito, Formosa, off buffalo and Zebu).

Specimens labeled *H. cornigera* var. *taiwana,* sent by Sugimoto from Karenko, Formosa, to the Rocky Mountain Laboratory, were compared with Burma material; since no differences were found, I regard this variety as a synonym of *cornigera.*

Male (Fig. 5A–F). Fourteen Java specimens range from 2.85 to 2.1 mm. long by 1.68 to 1.2 mm. wide, exclusive of capitulum. Scutum decidedly fusiform and widest at mid-length, a little more narrowed posteriorly than anteriorly, very glossy and reddish-brown to yellow, with anterior portion darker than posterior part; punctations unequal, with larger ones clearly delimiting pseudoscutum; very numerous, fine punctations confined to posterior half of scutum proper; cervical grooves forming deep pits anteriorly and short, shallow depressions posteriorly; dorsal foveae more clearly seen in some specimens than in others; lateral grooves short and inconspicuous, but in a few extending to region of pseudoscutum;

festoons much longer than wide, uniformly covered with very fine punctations in anterior half. Ventral body surface lighter, finely striate and punctate; genital opening large, opposite coxa II; anal opening opposite posterior border of spiracles; genital grooves nearly parallel anteriorly, but diverging widely in region of anal opening; arms of anal groove not reaching genital groove; spiracles comma-shaped. Legs strong and stout, especially third and fourth pair; coxa I elongate anteriorly, with single, very long, pointed spur posteriorly; coxa II much shorter, triangular, with sharp spur at middle of posterior border; coxa III with slightly shorter spur similar in position to coxa II; coxa IV with long, slender, internal spur and a much shorter, external spur; internal spur varies slightly in length, but less so than that of Burma material seen; tarsi long, tapering gradually; tarsus of leg one terminating in a very weak, inconspicuous spur; tarsi of other legs ending in a strong spur; pulvillus long, almost equal to claws in length. Basis capituli rectangular, 0.49 mm. long, wider than long; cornua long; palpal article two very salient laterally; article three with a sharp lateral spur; article two ventrally with two distinct spurs, or posterior border undulating faintly suggesting spurs; article three with a long, ventral spur; hypostome long, slightly wider at mid-length; dentition 5:5, with approximately ten small teeth per file.

Java and Burma forms agree in most respects, except for the scutum of the Burma material which is less markedly fusiform.

Female (Fig. 5G–L). Soemba specimen 3.0 mm. long by 1.9 mm. wide, exclusive of capitulum; two unengorged, Java specimens respectively 2.1 and 3.0 mm. long by 1.35 and 1.95 mm. wide, exclusive of capitulum; largest engorged female 8.7 mm. long by 6.3 mm. wide. Body elongate-oval, widest near mid-length, yellow-brown. Scutum dark, very glossy, 1.08 mm. long by 1.05 mm. wide for Soemba female and 1.0 mm. long by 0.9 mm. wide and 1.3 mm. long by 1.35 mm. wide for Java females; punctations relatively large, numerous and evenly distributed; cervical grooves deep anteriorly, continued posteriorly as shallow, parallel grooves not reaching margin of scutum; dorsal foveae large, a short distance behind scutum; marginal groove narrow, deep, including first two festoons on each side; festoons slightly broader than long; grooves separating festoons dark and deep. Ventral body surface lighter than dorsum, finely punctate, with very short, white inconspicuous hairs; genital opening opposite second and third coxae; anal opening opposite posterior half of spiracles; spiracles large, white and nearly circu-

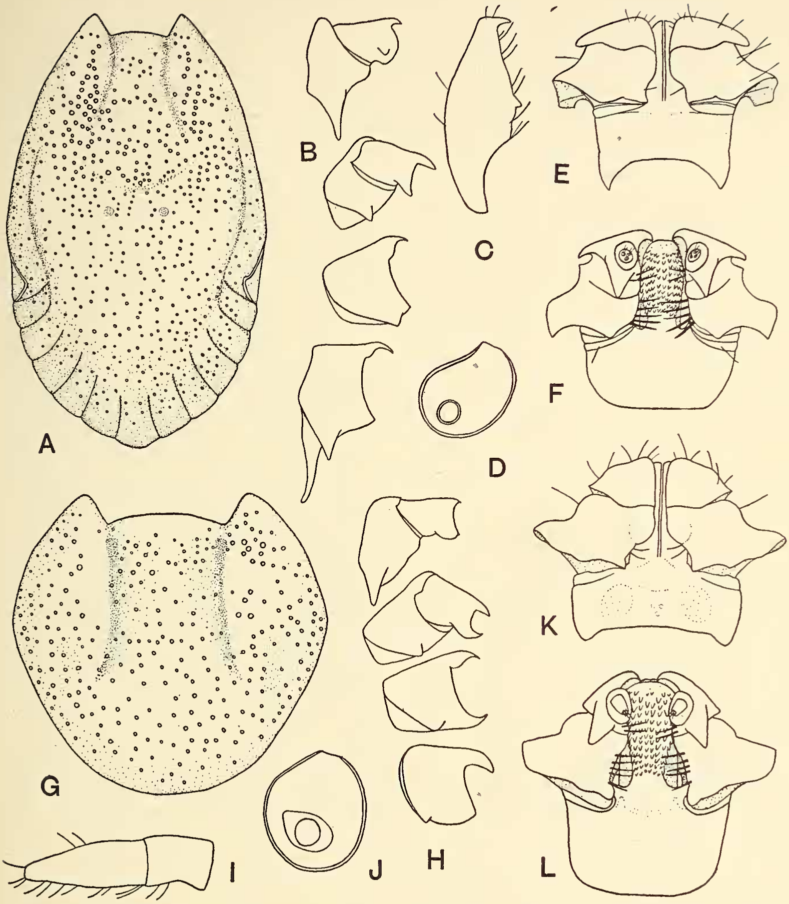


Fig. 5. *Haemaphysalis cornigera* Neumann. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, spiracle; E, capitulum in dorsal view; F, same in ventral view. G–L, female: G, scutum; H, coxae I–IV; I, tarsus IV; J, spiracle; K, capitulum in dorsal view; L, same in ventral view.

lar; genital grooves diverging gradually; anal grooves semi-circular, then diverging to join genital grooves. Legs long and covered ventrally with a double row of long, white hairs; coxa I with a long, sharp spur; coxae II and III with a single, short spur; coxa IV with a short, internal spur. Capitulum 0.58 mm. long for Soemba specimen and 0.42 mm. and 0.56 mm. long for Java specimens; basis slightly depressed between porose areas, rectangular, about twice as wide as long, lateral margins slightly convex; cornua short and prominent; porose areas large, oval and widely separated; article two salient at about mid-length; article three dorsally with a very short spur; ventrally, posterior border of article two undulating with faint suggestion of two spurs; ventrally, article three with a long, retrograde spur; hypostome small; dentition 4:4, with ten to twelve teeth per file.

The females from Burma and Indonesia agree in all respects.

Distribution and Hosts. Known from the Federated Malay States, British North Borneo, India, Singapore, Formosa, Indochina and the East Indies. In the East Indies it has been recorded from Sumatra (Neumann, 1897; Warburton and Nuttall, 1909; Warburton, 1926; Krijgsman and Ponto, 1931, 1932), Amboina (Oudemans, 1927), Java, Bali, Soemba, Borneo, Soembawa and Karimoendjowo Island (Krijgsman and Ponto, 1931, 1932). Specimens were seen from Soemba Island (Waingapoe, one female, off cow, in Kraneveld collection) and West Java (Oedjoeng Koelon and Miaonave, fourteen males and eighteen females, off *Bos sondaicus sondaicus,* in Museum of Comparative Zoölogy). Numerous specimens were also seen in the Rocky Mountain Laboratory from Myitkyina, Burma, taken off *Cervus unicolor, Muntiacus muntjak vaginalis, Tupaia belangeri versurae, Rattus rattus sladeni, Callosciurus sladeni midas,* man, *Pomatorrhinus hypoleucus hypoleucus, Turdus* sp. and *Gallus gallus gallus.*

Haemaphysalis hylobatis Schulze.

Haemaphysalis hylobatis Schulze, 1933, Arch. f. Hydrobiol., Suppl.-Bd. **12,** pp. 490–492, figs. 1–2 (6 ♂, 1 ♀, Ranau, Sumatra, off *Hylobates syndactylus;* holotype in Z. M. Berlin); 1936, Zeitschr. f. Parasitenk., **8,** pt. 5, pp. 524–526.

This species was not seen and the following descriptions are taken from Schulze.

Male. Scutum 2.0 mm. long by 1.3 mm. wide, very pale yellowish-olive; punctations coarse, uniform and closely set; cervical grooves short, comma-shaped and converge slightly; lateral groove distinct, including two festoons on each side; spiracular plate oval, with short projection. Coxal spurs short, broad and triangular, weakest on coxae I and IV. Basis twice as broad as long, sides converging slightly toward back; cornua stout, about as long as wide; palpal article two much broader than article three, externally and laterally salient, with a small, blunt spur on antero-internal border; palpal article three with a dorsal, retrograde spur; hypostome with 4:4 dentition.

Female. Scutum 1.0 mm. long by 1.0 mm. wide, nearly circular, pale yellow; punctations coarse and uniformly distributed; cervical grooves deep anteriorly, become shallow and divergent posteriorly; marginal groove, spiracular plate, coxae similar to those of male. Basis wider than in male, nearly three times as broad as long; cornua weaker and more blunt than in male; porose areas near margins and not very distinct; palps similar to male, but somewhat larger; hypostome with 4:4 dentition.

Haemaphysalis hystricis Supino.

Haemaphysalis hystricis Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 237 (♂, ♀, Yado-Carin Ascinii-Chebà, Carin-Chebà, Burma, off "*Hystrix bengalensis* = *Hystrix hodgsoni*, "*Ursus torquatus*" = *Euarctos thibetanus thibetanus;* cotypes Genoa M.); 1897, *Op. cit.,* (2) **3**, pt. 2, p. 252, Pl. 13, figs. 19–20. Neumann, 1897, Mém. Soc. Zool. France, **10**, pp. 342–343. Warburton, 1908, Proc. Cambridge Philos. Soc., **14**, pt. 5, pp. 518–519, fig. 11. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 152. Warburton, 1910, Parasitology, **3**, pt. 4, p. 396 (locality uncertain, possibly Burma, off *Geoemyda spinosa*). Nuttall and Warburton, 1915, Ticks, **1**, pt. 3, *Haemaphysalis*, pp. 353, 357, 422–426, figs. 354–357 (extensive distribution and host list). Kishida, 1922, Zool. Mag., Tokyo, **34**, 408, pp. 854, 855. Warburton, 1926, Treubia, **8**, pts. 3–4, pp. 279, 280 (♀, Bukit Kaba, Benkoelen, Sumatra, off *Arctonyx collaris hœvenii;* Babi Island, off Nias pig). Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 253–254, fig. 11 (♂, ♀, Assam, off *Felis tigris;* ♂, Assam; ♀, ? Burma, off *Geoemyda spinosa;* ♂, ♀, Bengal). Schulze, 1931, Sitz.-Ber. Abhand. Naturf. Gesellsch. Rostock, (3) **3**, p. 54, fig. 5 (n, Tsingtau, China, off hedgehogs). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 142, map 3; 1932, Veeartsenijk. Meded., No. **79**, pp. 14–15, 33, 34, figs. 14–15, map 3 (♂, ♀, Sumatra, Bali, Celebes, Karimoendjowo Island, Riouw Island, off cow and buffalo). Kishida, 1935, Lansania, **7**, 69, pp. 138–139. Sugimoto, 1935, Taiwan-No-Chikusan, **3**, pt. 9, pp. 26–27. Schulze, 1935, Zool. Anz., **112**, pts. 9–10, p. 234 (Formosa). Sugimoto, 1936, Journ. Soc. Trop. Agric., Formosa, **8**, pt. 4, p. 336 (Formosa); 1936, Journ. Cent. Soc. Vet. Med., Tokyo, **49**, pt. 7, p. 581. Ogura, 1936, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. Formosa, **19**, pt. 2, pp. 81–82, figs. 19–23 (♂, ♀, Formosa, off dog and wild boar). Sugimoto, 1937, Journ. Cent. Soc. Vet. Med., Tokyo, **50**, pt. 5, pp. 311–313; 1937, Journ. Soc. Trop. Agric., Formosa, **9**, pt. 3, p. 287. Schulze, 1939, Zeitschr. f. Parasitenk., **10**, pt. 6, p. 728 (Burma). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 52–55, 85, 90, Pls. 33, 34, 46 (♂, ♀, Haut Chlong, off Sambar deer).

Haemaphysalis bispinosa Neumann, 1901, [*nec* Neumann, 1897], Mém. Soc. Zool. France, **14**, pp. 261–262 (1 ♂, 4 ♀, Macao, China, off "*Paradoxurus larvatus*" = *Paguma larvata;* 2♀, Japan).

Haemaphysalis semermis Neumann, 1901, *Op cit.*, p. 263 (1 ♂, Bengkalis Island; type in Paris M.).

Haemaphysalis histricis [*sic*] Neumann, 1902, Arch. de Parasit., **6**, pt. 1, p. 128.

Haemaphysalis birmaniae Neumann, 1911, [in part, *nec* Supino, 1897], Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 109.

Male (Fig. 6A–E). Three Sumatra specimens respectively 3.0, 2.7, and 2.5 mm. long by 2.1, 2.0, and 2.0 mm. wide, exclusive of capitulum. Body elongate-oval, narrowed slightly anteriorly, widest at mid-length. Scutum yellow to light brown; punctations small, shallow, irregularly distributed; cervical grooves small, forming deep pits anteriorly and shallow, diverging grooves posteriorly; dorsal surface irregularly and weakly sculptured with fairly shallow depressions; pseudoscutum set off by slight elevation; lateral grooves lacking, or at most present as a very short groove in front of first festoon on each side; festoons about twice as long as broad. Ventral body surface light yellow, finely punctate, with numerous short, white, inconspicuous hairs; genital opening oppo-

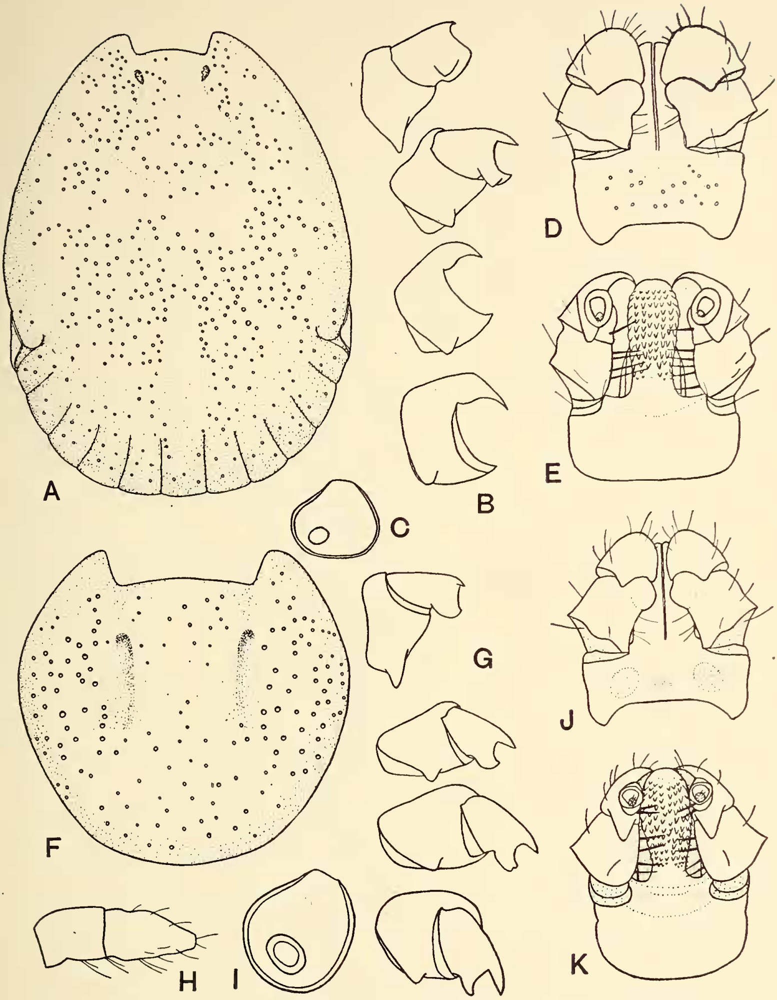


Fig. 6. *Haemaphysalis hystricis* Supino. A–E, male: A, scutum; B, coxae I–IV; C, spiracle; D, capitulum in dorsal view; E, same in ventral view. F–K, female: F, scutum; G, coxae I–IV; H, tarsus IV; I, spiracle; J. capitulum in dorsal view; K, same in ventral view.

site coxa II; anal opening opposite spiracle; spiracle comma-shaped with distinct, dorsal process; genital grooves diverging widely around anus; arms of anal groove almost reaching genital grooves. Legs long, stout and very hairy; coxa I with relatively long, external spur; coxae II–IV with a shorter spur; trochanter I with a distinct dorsal and ventral retrograde spur; tarsi sloping fairly rapidly; pulvillus about two-thirds length of claws. Capitulum 0.56 mm. long; basis rectangular, with sides nearly straight; cornua large, about as wide as long; palps only slightly salient laterally; palpal articles two and three subequal; article two with a lobe-like projection on antero-internal margin; article three with a distinct dorsal spur on middle of posterior border and a strong, ventral spur; hypostome short; 4:4 dentition, with ten to twelve teeth per file.

Female (Fig. 6F–K). Unengorged Sumatra specimen 3.3 mm. long by 2.3 mm. wide, exclusive of capitulum. Body elongate-oval, widest at mid-length. Scutum of five specimens from 1.2 to 0.075 mm. long to 1.5 to 1.0 mm. wide, yellow, with scapulae darker; punctations medium, numerous, regularly distributed; cervical grooves as deep pits somewhat removed from anterior margin, continuing posteriorly as slightly diverging, shallow grooves not reaching margin of scutum. Abdomen with medium and very small punctations; long, narrow, marginal grooves including first two festoons on each side; festoons slightly broader than long; abdomen ventrally lighter in color, with numerous, fine, inconspicuous punctations; spiracles nearly circular, narrowed slightly dorsally; genital opening opposite coxa II; anal opening opposite spiracles; genital grooves diverging gradually, but more widely in region of anal opening; arms of anal groove reaching genital grooves. Legs and coxae as in male. Capitulum 0.64 mm. long; basis rectangular, about three times as wide as long; porose areas large, oval, deep, far apart, with a small pit between them; cornua strong, large, blunt; palps about twice as long as wide, slightly salient laterally; article two longer, with lobe-like protuberance on antero-internal margin; article three with a distinct dorsal spur, and a longer ventral spur; hypostome short; 4:4 dentition, with ten to twelve teeth per file.

Distribution and Hosts. Known from Burma, India, Assam, China, Federated Malay States, Borneo, East Indies, Ceylon, Formosa and Indochina. In the East Indies it has been recorded from Bengkalis (Neumann, 1901), Sumatra (Nuttall and Warburton, 1915; Warburton, 1926; Krijgsman and Ponto, 1931, 1932), Babi Island (Warburton, 1926), Celebes (Nuttall and Warburton, 1915; Krijgsman and Ponto, 1931, 1932), Bali, Karimoendjowo Island, Siberoet, and Riouw Island (Krijgsman and Ponto, 1931, 1932). Specimens were seen from Sumatra (Lhokseumawe, one female, off buffalo; Medan, one male, off domestic pig; Padangsidimpoean, one male, off horse; Benkoelen, one female, off dog; Tandjoengkarang, one female, off dog; all in Kraneveld collection; between Takingeun and Bireuën, one female, in Museum of Comparative Zoölogy) and Celebes (Makale, one female, off buffalo, in Kraneveld collection). One female taken off *Geoemyda spinosa* in India and three specimens collected by H. S. Fuller in 1944 in Burma (Shaduzup, male, off man; Tingkawk Sakan, female, off man; Shingbwiyang, male, off man) were seen in the Museum of Comparative Zoölogy. In addition specimens were seen in the Rocky Mountain Laboratory from Burma, Assam, India and Formosa taken off a wide variety of hosts.

Biology. This species is primarily a parasite of mammals, but it has been recorded off the tortoise, *Geoemyda spinosa* (Nuttall and Warburton, 1915; Sharif, 1928). In the Museum of Comparative Zoölogy was seen one engorged female from India also taken off *Geoemyda spinosa*, and from these records it would appear that it is occasionally found on tortoises.

Haemaphysalis koningsbergeri Nuttall and Warburton.

? *Haemaphysalis leachi* var. *australis* Neumann, 1905, Arch. de Parasit., **9,** pt. 2, p. 238 (2 ♂, Sumatra, off *Felis tigris;* 7 ♀, New South Wales, off horse). Warburton, 1910, Parasitology, **3,** pt. 4, p. 396 (off *Felis tigris*).

Haemaphysalis koningsbergeri Warburton and Nuttall, 1909, Parasitology, **2,** pts. 1–2, pp. 65–66, figs. 11–12 (2 ♂, 2 ♀, Java, off *Felis pardus;* cotypes in Brit. Mus.). Schulze, 1934, Zeitschr. f. Parasitenk., **7,** pt. 2, pp. 168–169 (larger dark form, 10 ♂, 3 ♀, Tjiboeni, Java, off *Paradoxurus hermaphroditus javanicus;* 3 ♀, Pangrango, Java, off *Felis bengalensis javanensis;* 2 ♂, 1 ♀, Pangrango, Java, off *Helictis orientalis;* 2 n, Tjiboeni, Java, off *Ratufa bicolor bicolor;* smaller light form, 4 ♂, 1 ♀, 7 n, Tjiboeni, Java, off *Petaurista petaurista petaurista;* 1 ♂, 2 ♀, Mt. Karang, Java, off *Petaurista petaurista petaurista*); 1938, Zeitschr. Morph. Oekol. Tiere, **34,** pt. 1, p. 140, fig. 4*b* (morphological).

Haemaphysalis leachi Nuttall and Warburton, 1915, Ticks, **1,** 3, *Haemaphysalis,* pp. 355, 357, 460–476, figs. 409–410 (in part: ♂, ♀, Sumatra, off tiger; Java, off *Felis pardus;* Upper Sarawak, Borneo, off dog; Pahang, Fed. Malay States, off tiger, *Paradoxurus, Viverra* and *Felis chaus;* Ulu Gombak, Selangor, Fed. Malay States, off "*Ursus malayanus*" = *Helarctos malayanus;* Kampong Batu, Negri Sembilan, Fed. Malay States, off *Felis pardus*). Warburton, 1926, Treubia, **8,** pts. 3–4, pp. 279, 280 (♂, ♀, Sinabang, Simeuloeë, off *Paradoxurus hermaphroditus;* Andalos (Tandjung), Sumatra's west coast, off *Martes flavigula henrici,* "*Nycticebus buku*" = *Nycticebus coucang*). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 143, map 3; 1932, Veeartsenijk, Meded., No. **79,** pp. 16–17, 33, 34, figs. 18–19, map 3 (♂, ♀, n, Java, Sumatra, Borneo, Simeuloeë, Bawean, off "*Mus rattus*" = *Rattus rattus, Helictis orientalis* and panther). Not of Audouin, 1827.

Haemaphysalis bartelsi Schulze, 1938, Zeitschr. Morph. Oekol. Tiere, **34,** pt. 1, p. 140, fig. 5*a* (lighter, smaller form of *H. koningsbergeri;* type probably in P. Schulze Coll.).

I have seen three males and one female from Tjibodas, Java, which I regard as *koningsbergeri.* These were compared with numerous specimens of *leachii* from Africa, and though there is a superficial resemblance, they differ enough to be regarded as a distinct species and not as a variety of *leachii.* The main difference between true *leachii* and *koningsbergeri,* in both sexes, lies in the structure of the capitulum. In *koningsbergeri* the two palps are bell-shaped with the external lateral margin slightly concave; article two is longer, more erect and its posterior border does not terminate in a distinct dorsal spur; article three is as long as wide; and the basis is wider. In *leachii* the palps are compressed, with the external lateral margin straight or slightly convex; article two is compressed, shorter, and has a distinct dorsal spur on the posterior border; article three is wider than long; and the basis is narrower.

In 1934 Schulze stated that *koningsbergeri* appeared in two different forms, a larger, darker one found on many hosts and a smaller, lighter one found only on *Petaurista.* In 1938 he decided that the smaller forms represented a new species which he called *bartelsi.* Size alone is not a good character for separating species,

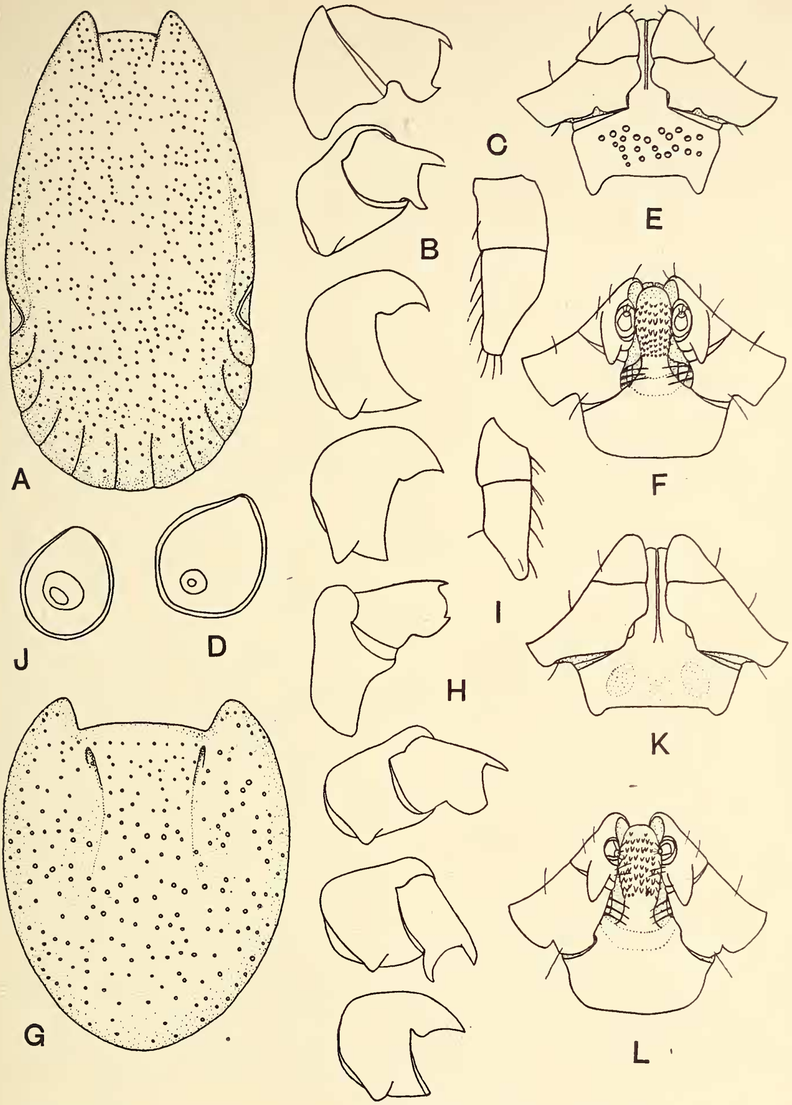


Fig. 7. *Haemaphysalis koningsbergeri* Nuttall and Warburton. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, spiracle; E, capitulum in dorsal view; F, same in ventral view. G–L, female: G, scutum; H, coxae I–IV; I, tarsus IV; J, spiracle; K, capitulum in dorsal view; L, same in ventral view.

for the amount of nymphal feeding has a direct relation to adult size, and large and small forms are known to occur in many species. I regard *bartelsi* as a synonym of *koningsbergeri.*

Neumann in 1905 said that *leachii* was strictly an African species, and he placed specimens from Sumatra and Australia in a new variety, *australis.* It is probable that the material Neumann had from Sumatra is identical with *koningsbergeri,* but there is no way at present of being certain. If found to be the same as *koningsbergeri, australis* will have priority as the earlier name.

Male (Fig. 7A–F). Three Java specimens respectively 2.5, 2.4 and 2.4 mm. long by 1.26, 1.32, and 1.25 mm. wide, exclusive of capitulum. Body much longer than wide, widest at posterior end, yellow-brown; punctations medium, deep, partially confluent; cervical groove as a deep anterior pit continuing posteriorly as a very shallow groove; lateral grooves shallow, very inconspicuous, including first festoon on each side and extending only a very short distance anteriorly; festoons little over twice as long as wide, with grooves separating them distinct and deep. Abdomen ventrally lighter, finely striate; genital opening opposite coxa II, with a distinct cover having a posterior fringe of many, short hairs; anal opening opposite spiracles; spiracles large, oval and with a blunt, dorsal continuation; genital grooves diverging gradually till reaching region of anal opening and then more divergent; arms of anal groove not reaching genital grooves. Legs normal; tarsi relatively short, narrow abruptly at end and not ending in a spur; pulvillus nearly as long as claws; coxa I with a short, blunt spur; coxae II–IV with a blunt spur, slightly shorter than that of coxa I; numerous, long, conspicuous hairs on coxal plates. Capitulum 0.49 mm. long by 0.728 mm. wide; basis wider than long, widest anteriorly; large punctations grouped together near center; cornua long and sharp; palps slightly bell-shaped, with external lateral margin concave; article two longer than article three, very salient laterally; internal lateral margin of article two with a prominent lobe-like extension; article three triangular, slightly wider than long and with a long ventral spur; hypostome short; dentition, 4:4, with approximately eight teeth per file.

Female (Fig. 7G–L). Single, engorged specimen 6.9 mm. long by 4.5 mm. wide, exclusive of capitulum. Scutum elongate-oval, pointed posteriorly, 1.2 mm. long by 1.05 mm. wide, reddish-brown in anterior two-thirds and remainder yellow; punctations numerous, medium, deep, uniformly distributed; cervical grooves deep anteriorly, converging toward center, becoming shallow posteriorly and then diverging again. Abdomen uniformly covered with medium punctations; festoons in specimen distorted and not clearly seen; ventral surface lighter, finely striate; genital opening opposite coxa II; anal opening posterior to spiracle; spiracle oval and pointed dorsally. Tarsi slightly longer and not tapering as suddenly as those of male; coxae as in male. Capitulum 0.64 mm. long by 0.91 mm. wide; basis rectangular, widest anteriorly being about two and a half times as wide as long; porose areas deep and elongate-oval; palps similar to male; hypostome small; dentition 4:4, with approximately eight teeth per file.

Distribution and Hosts. So many of the records are uncertain that the complete distribution can not be given. It is definitely known in the East Indies from Java (Warburton and Nuttall, 1909, 1915; Schulze, 1934; Krijgsman and Ponto, 1931, 1932), Sumatra (Neumann, 1905 ?; Nuttall and Warburton, 1915; Warburton, 1926; Krijgsman and Ponto, 1931, 1932), Simeuloeë (Warburton, 1926; Krijgsman and Ponto, 1931, 1932) and Bawean Island (Krijgsman and Ponto, 1931, 1932). Three males and one female were seen in the Museum of Comparative Zoölogy from Tjibodas, Mt. Gede, Java, taken off *Mydaus javanensis javanensis* by Palmer and Bryant.

It is probable that *koningsbergeri* is also found in Australia (Neumann, 1905). I doubt if it occurs as far west as Burma, for I examined many specimens from Myitkyina in the Rocky Mountain Laboratory and found them to be very close to typical *leachii*. Specimens from Calcutta, India, in the Museum of Comparative Zoölogy are also very close to typical *leachii*.

Haemaphysalis papuana Thorell.

Haemaphysalis papuana Thorell, 1882, Ann. Mus. Civ. Genova, **18,** pp. 62–66, 69 [*pp.* 46–50, 53 in reprint], Pl. 6, figs. 40–45 (1 ♂, 1 ♀, Ramoi, New Guinea; type in Genoa M.). Neumann, 1897, Mém. Soc. Zool. France, **10,** pp. 336–337, 358, 359. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 458, 459. Warburton, 1908, Proc. Cambridge Philos. Soc., **14,** pt. 5, pp. 514–516, fig. 7 (♂, ♀, n, Sarawak, Borneo). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 154. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 106, 107, 108. Nuttall and Warburton, 1915, Ticks, **1,** pt. 3, *Haemaphysalis,* pp. 355, 359, 360, 361, 404–

407, figs. 338–341 (♂, ♀ n, l, Borneo, Java, Sumatra, Fed. Malay States, off dog, pig, "*Ursus malayanus*" = *Helarctos malayanus*, *Felis pardus*, wild pig, tiger). Fielding, 1926, Comm. Austral. Service Publ., (Trop. Div.) No. **9**, pp. 58–60, fig. 22. Vitzthum, 1931, Résultats Scientif. Voyage Indes Orient. Néerland. Prince Léopold, **3**, pt. 5, p. 31 (at harbor of Lomira, New Guinea). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 142, map 3; 1932, Veeartsenijk. Meded., No. **79**, pp. 11–12, 33, 34, figs. 8–9, map 3 (♂, ♀, Java, Soembawa, Soela, Sangihe, Halmahera, Alor, Amboina, Saparoea and New Guinea, off buffalo, cow, horse, dog and pig). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 47–49, 87, 91, Pls. 27–28 (♂, Cambodge, off *Felis pardus*; ♂, Haut Chlong, off deer; ♀, Haut Chlong, off "*Cervus aristotelis*" = *Cervus unicolor*).

? *Haemaphysalis papuana* Rainbow, 1906, Records Australian Mus., **6**, p. 165. Yakimov and Kohl-Yakimov, 1910, Arch. de Parasit., **14**, p. 417 (Caucasia). Tryon, 1917, Ann. Rept. Queensland Dept. Agric. Stock for 1916–1917, pp. 49–63; 1919, *Op. cit.*, for 1918–1919, pp. 37–49 (off cattle, Queensland). Ferguson, 1925, Australian Zool., **4**, p. 31.

[*non Haemophysalis* [*sic*] *papuana* Canestrini, 1884, Atti Ist. Veneto Sci. Lett. Art., (6) **2**, pt. 5, pp. 705–706, Pl. 6, fig. 4 (Australia)].

Male (Fig. 8A–F). Timor specimen 2.58 mm. long by 1.96 mm. wide, exclusive of capitulum. Scutum yellow-brown, elongate oval, widest at mid-length; one of several raised tracts clearly delimits pseudo-scutum; median tract of irregular width beginning near posterior border of pseudo-scutum, interrupted midway of its length, not reaching posterior border of scutum; small, irregularly-shaped, raised tracts along lateral margins of scutum; punctations medium, deep, and absent from all raised portions; cervical grooves short, deep pits, slightly removed from anterior margin of scutum and continuing posteriorly a very short distance as broad, shallow grooves; lateral groove extending from first festoon to border of pseudo-scutum; festoons much longer than broad. Ventrally body lighter, finely striate, finely punctate; genital opening relatively large, opposite coxa II; anal opening opposite posterior border of spiracles; genital grooves far apart, at first sub-parallel, diverging widely around anal opening; arms of anal groove reaching genital

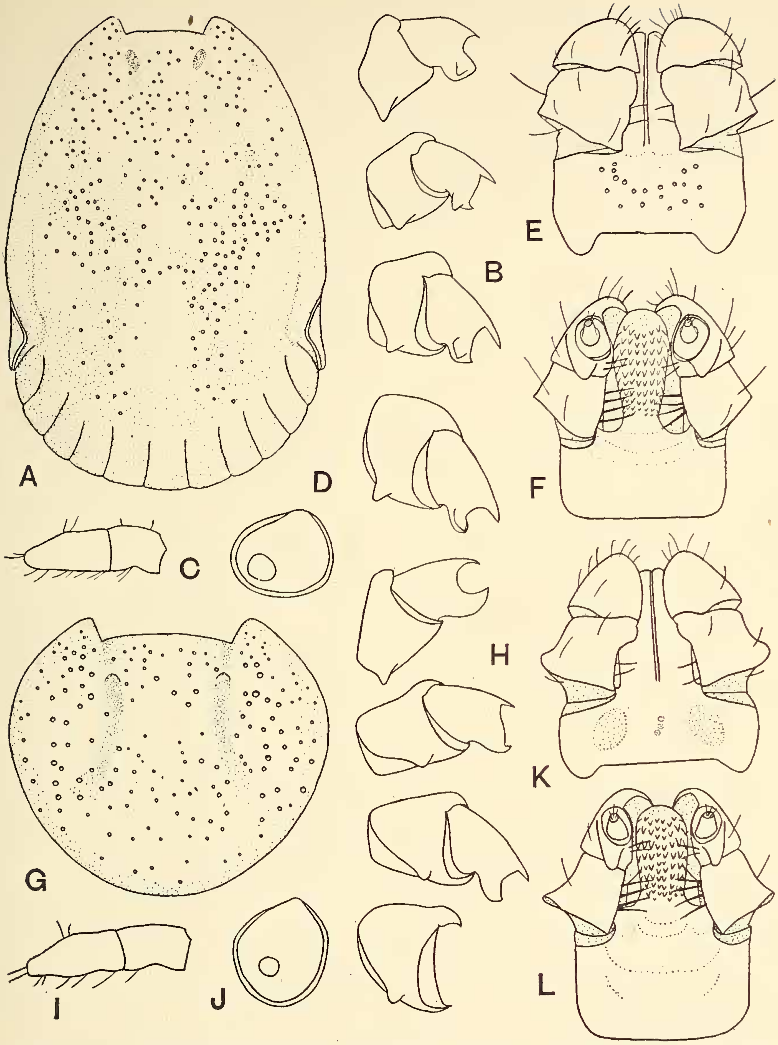


Fig. 8. *Haemaphysalis papuana* Thorell. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, spiracle; E, capitulum in dorsal view; F, same in ventral view. G–L, female: G, scutum; H, coxae I–IV; I, tarsus IV; J, spiracle; K, capitulum in dorsal view; L, same in ventral view.

groove; spiracles oval, with a distinct dorsal process. Legs dark, with a single row of long, white hairs dorsally and two rows ventrally; coxa I with one short spur; coxae II, III and IV with a shorter spur; all trochanters with a short spur; tarsi relatively short, with dorsal surface of each slightly raised at about midlength and tapering from this point. Capitulum 0.49 mm. long; basis rectangular with conspicuous punctations dorsally; cornua large and blunt; palps only slightly salient dorsally; articles two and three nearly equal; dorsally article two with a large, lobe-like process on internal, lateral border; article three without dorsal retrograde spine, but posterior border projecting slightly at this point; posterior border of article two pointed ventrally; a very short spur on article three; hypostome short; 4:4 dentition, with 9–10 teeth per file.

Female (Fig. 8G–L). Unengorged specimen 2.85 mm. long by 2.1 mm. wide, exclusive of capitulum. Scutum yellow-orange, from 1.2 to 0.9 mm. long by 1.35 to 0.96 mm. wide in four specimens; punctations relatively large, evenly distributed; cervical grooves deep, about one-half length of scutum, and region between grooves raised above rest of scutum; large punctations sparsely distributed on abdomen; marginal grooves long, narrow, deep, beginning at side margins of scutum and ending at region of first festoon; festoons about as wide as long; grooves separating each festoon deep. Abdomen ventrally lighter, with many small punctations; spiracles oval, with a weak, dorsal protuberance; genital opening opposite coxa II; anal opening opposite spiracles; genital grooves divergent, with arms of anal groove touching genital grooves. Coxal spurs slightly shorter than those of male; tarsi tapering gradually. Capitulum 0.53 mm. long; basis rectangular, about twice as wide as long; cornua short and blunt; porose areas large, oval, distinct, far apart; palpal article two slightly longer than article three; palps resembling those of male in all other respects; article three dorsally with posterior border protruding slightly, and ventrally with distinct spur; hypostome short; 4:4 dentition, with approximately ten teeth per file.

Distribution and Hosts. Recorded from New Guinea, Borneo, Indochina, Fed. Malay States, Caucasia (?), and Australia (?). It has been recorded in the East Indies from Sumatra (Nuttall and Warburton, 1915), Java (Nuttall and Warburton, 1915; Krijgsman and Ponto, 1931, 1932), Soembawa, Soela, Sangihe, Halmahera, Alor, Amboina, Saparoea (Krijgsman and Ponto, 1931, 1932).

Specimens were seen from Sumatra (Padangsidimpoean, five nymphs, off dog, in Kraneveld collection; Medan, two males, in Rocky Mountain Laboratory), Java (Djember, one female, off pig; Oedjoengkoelon, one male, off *Bos sondaicus sondaicus,* in Museum of Comparative Zoölogy), Celebes (Makale, one female, off pig, in Kraneveld collection) and Timor (Koepang, one male and two females, off pig, in Kraneveld collection). Specimens were also seen in the Rocky Mountain Laboratory from New Guinea (Dobadura), Owi Island and Borneo (Sarawak).

Haemaphysalis toxopei Warburton.

Haemaphysalis toxopei Warburton, 1927, Parasitology, **19,** pt. 4, pp. 407–408, fig. 3 (12 ♂, 1 ♀, Boeroe, off bat; cotypes probably in Amsterdam M.). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 143, map 3; 1932, Veeartsenijk. Meded., No. **79,** pp. 17, 33, fig. 20, map 3. Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, p. 81, Pl. 60.

This species was not seen, but is probably a synonym of *H. kinneari;* more specimens may afford distinguishing characteristics between these females, and they may help decide if the male of *H. toxopei* is the unknown male of *H. kinneari.*

Male. Scutum 2.5 mm. long by 2.0 mm. wide, broad oval; punctations very fine, numerous and shallow; lateral grooves absent; cervical grooves as tiny pits; spiracle large and comma-shaped. Coxa I with a single, strong spur; coxae II–IV with a single, shorter spur near middle of posterior border; very slight, diminishing spurs on trochanters. Basis twice as broad as long, punctate; cornua fairly strong; palpal articles two and three equal; article two only slightly salient laterally, without spurs; article three with a slight indication of a dorsal spur and a strong, retrograde, ventral spur; hypostome 5 : 5, with innermost row very small.

Female. Scutum circular; cervical grooves well marked, sinuous, reaching posterior border; punctations numerous and shallow; spiracle similar to that of male. Coxal spurs less pronounced; trochantal spurs lacking. Basis twice as broad as long; cornua slight; porose areas oval, far apart and with a median depression between them; hypostome with 4 : 4 dentition.

Haemaphysalis traguli Oudemans.

Haemaphysalis traguli Oudemans, 1928, Ent. Ber. Nederl. Ent. Ver., **7,** pt. 164, pp. 376–377 (2 ♂, 2 ♀, 20 larvae, Berhala

Island, off *Tragulus kanchil;* types now in Leiden M.). Schulze, 1934, Zeitschr. f. Parasitenk., **8**, pt. 2, pp. 168, 169, fig. 1 (1 ♀, Wijnkoops Bay, Java, off "*Tragulus kanchil pelandoc*" = *Tragulus kanchil kanchil*).

Haemaphysalis monospinosa Krijgsman and Ponto, 1932, Veeartsenijk. Meded. No. **79**, pp. 18–19, 33, fig. 22, map 3 (♂, Berhala Island, off *Tragulus kanchil;* type in Buitenzorg Zool. M.); 1933, Zeitschr. f. Parasitenk., **5**, pt. 2, pp. 409–410, fig. 2. Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 80, 86, Pl. 62.

This species was not seen, and the description of the male is from Oudemans, 1928, and Krijgsman and Ponto, 1932, and that of the female is from Oudemans, 1928, and Schulze, 1934.

Male. Scutum of Oudemans' specimen 1.865 mm. long by 1.065 mm. wide and in Krijgsman's specimen 1.7 mm. long by 1.0 mm. wide; cervical grooves very short, crescent-shaped; marginal grooves very short, distinct; punctations superficial, numerous, regularly distributed. Coxa I much longer than broad, nearly diamond-shaped; coxae II–IV with a short, broad, lobe-like spur; trochantal spurs well developed. Basis capituli broader than long; cornua very strongly developed, extending slightly beyond anterior border of scutum; contours of palpal article two very salient laterally; article three with a very long, ventral, retrograde spur; hypostome with 4:4 dentition.

Female. Scutum slightly broader than long, in Oudemans' two specimens 0.854 mm. long by 1.0 mm. wide and 0.808 mm. long by 0.881 mm. wide; punctations large, uniformly distributed. Coxa I with two broad spurs; coxae II–IV with a broad, ridge-like spur. Basis capituli about three times as broad as long; porose areas small, oval, widely separated; cornua large, broad and blunt; palpal articles two and three salient laterally; hypostome with 4:4 dentition; palpal article three ventrally with a very long, retrograde spur.

Haemaphysalis wellingtoni Nuttall and Warburton.

Haemaphysalis wellingtoni Nuttall and Warburton, 1908, Proc. Cambridge Philos. Soc., **14**, pt. 4, pp. 397–398, figs. 9–11 (1 ♂, 2 ♀, Sarawak, Borneo, off domestic fowl; cotypes in Brit. Mus.). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 157. Nuttall and Warburton, 1915, Ticks, **1**, pt. 3, *Haemaphysalis*, pp. 356, 358, 359, 361, 479–

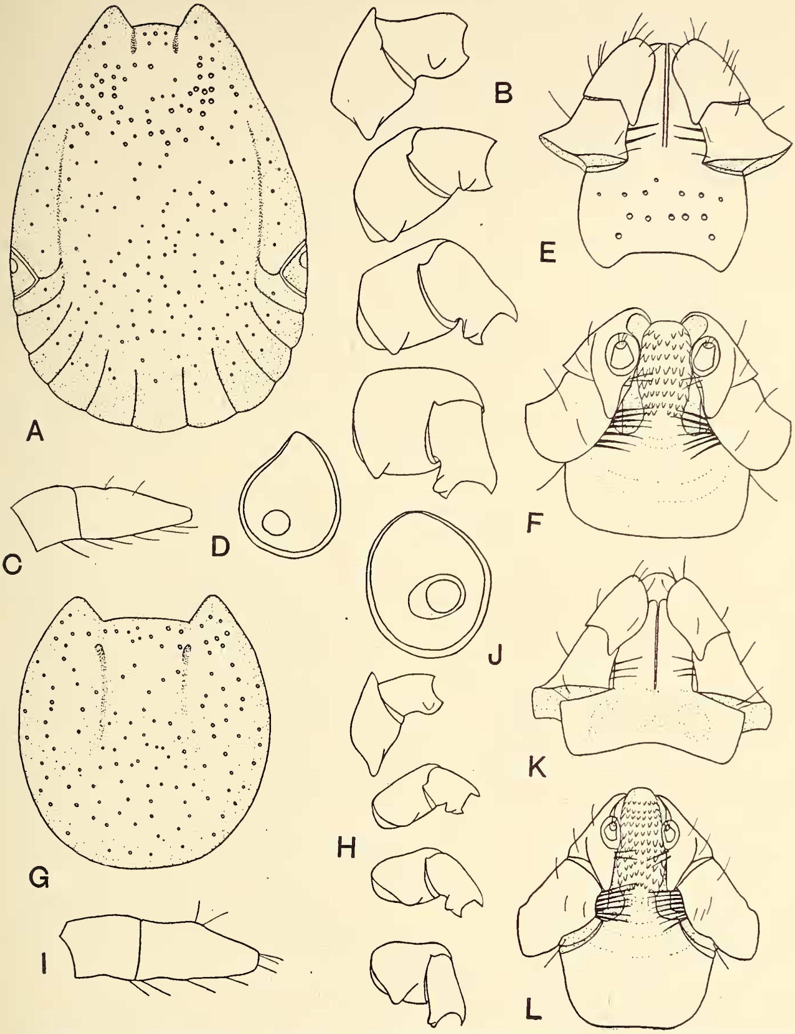


Fig. 9. *Haemaphysalis wellingtoni* Nuttall and Warburton. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, spiracle; E, capitulum in dorsal view; F, same in ventral view. G–L, female: G, scutum; H, coxae I–IV; I, tarsus IV; J, spiracle; K, capitulum in dorsal view; L, same in ventral view.

482, figs. 416–420 (♂, ♀ n, l, Borneo, Sumatra, Fed. Malay States, Siam, Andaman Islands, off domestic fowl, *Bos bubalis bubalis,* goose, buffalo, dog, turkey). Sharif, 1928, Records Indian Mus., **30,** pt. 3, pp. 267–268, fig. 17 (♂, ♀, Andaman Islands; ♀, Assam, off cock). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 142–143, map 3; 1932, Veeartsenijk. Meded., No. **79,** pp. 15–16, 33, figs. 16–17, map 3 (♂, ♀, Java, New Guinea, off hens). Schulze, 1939, Zeitschr. f. Parasitenk., **10,** pt. 6, pp. 725–726 (♂, ♀, Burma, off *Gallus gallus*). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 70–72, 88, 91, Pls. 53–54 (♂, ♀, Krong-Pha and Djiring in So. Annam, and Cambodge, off wild fowl).

Male (Fig. 9A–F). Seven partially engorged, Sumatra specimens from 1.34 to 1.42 mm. long by 1.2 to 1.12 mm. wide, exclusive of capitulum. Scutum elongate-oval, narrowed anteriorly, yellow-brown to brown, very glossy; punctations small, slightly unequal, fairly numerous, larger and less numerous on anterior third of scutum; cervical grooves deep and short; lateral groove on each side including first festoon and extending to region corresponding to pseudoscutum; festoons longer than wide, with a few punctations on anterior half. Body ventrally lighter, and finely striate; spiracle oval, with dorsal surface decidedly narrowed; genital opening opposite coxa II; anal opening opposite posterior border of spiracles. Legs strong, with a double row of long, white hairs ventrally; coxa I with a single, short spur; coxae II–IV with a single spur slightly shorter than that of coxa I; tarsi short, tapering gradually, not terminating in spurs; pulvillus nearly as long as claws. Capitulum 0.35 mm. long; basis punctate, broader than long; cornua short and blunt; palpal articles nearly equal; article two strongly salient laterally; article three with a dorsal, retrograde spur at inner angle and a strong, ventral spur; hypostome short; dentition 4:4, with seven to nine teeth per file.

Female (Fig. 9G–L). Unengorged, Sumatra specimen 1.75 mm. long by 1.26 mm. wide, exclusive of capitulum. Body oval, widest at mid-length. Scutum yellow-brown, oval, and slightly longer than wide, in twenty specimens from 0.77 to 0.91 mm. long by 0.71 to 0.81 mm. wide; punctations medium, numerous, and more numerous in posterior half of scutum; cervical grooves long, deep and parallel. Abdomen dark and uniformly covered with punctations; marginal groove distinct and long, including first three festoons on each side; festoons nearly as wide as long. Ventral body surface lighter, with numerous, medium punctations and a few, short, white hairs posteriorly; genital opening opposite coxae II and III; anal opening opposite spiracles; spiracle nearly circular. Coxa I with a long, slender spur; coxae II and III with a shorter, broader spur; coxa IV with a short, narrow spur. Capitulum 0.49 mm. long; basis nearly three times as wide as long; posterior margin concave; porose areas oval, large, widely separated, with a depression between them; palps in general resemble those of male, but article two is slightly longer; hypostome short, widest at mid-length; dentition 4:4, with approximately eleven teeth per file.

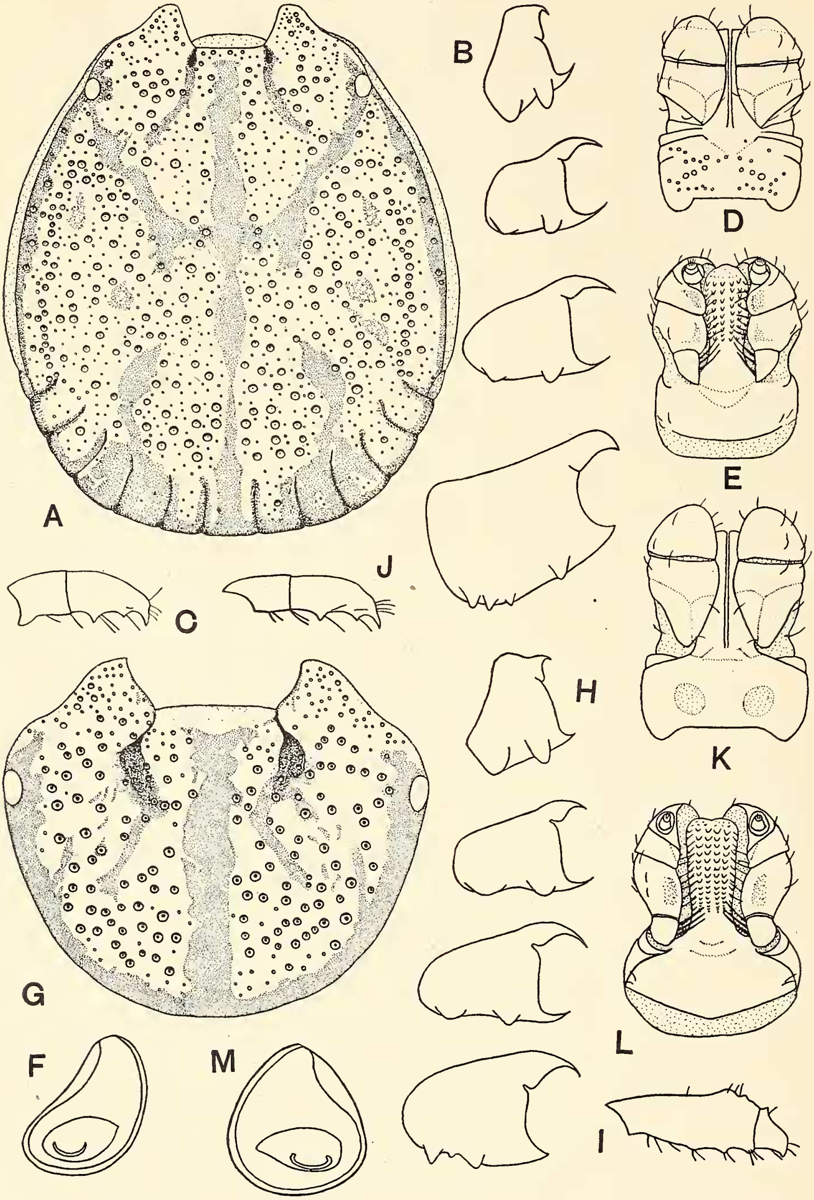
Distribution and Hosts. Known from Borneo, Fed. Malay States, Siam, Andaman Islands, India, New Guinea, Burma, East Indies and Indochina. It has been recorded in the East Indies from Sumatra (Nuttall and Warburton, 1915) and Java (Krijgsman and Ponto, 1931, 1932). Numerous males and females were seen from Sumatra (Lhokseumawe and Koetaradja, off domestic fowl, in Kraneveld collection). Specimens were also seen in the Rocky Mountain Laboratory from Myitkyina, Burma, taken off a great variety of birds and mammals.

Genus *Dermacentor* C. L. Koch, 1844

Schulze established the genus *Indocentor* in 1933 for the species limited to India, China and the East Indies. He placed great stress on the shape of the male scutum in separating this genus, but in a series of twenty-three males in the Museum of Comparative Zoölogy, collected off one host at Doi Angha, Siam, by H. Coolidge, Jr., the shape of the scutum varies from that characteristic of *Indocentor* to that characteristic of *Dermacentor*. Some specimens in the series are intermediate between these two, and it is difficult to place them definitely in either group. The few differences that do exist are of specific rank only; I, therefore, regard *Indocentor* Schulze as a synonym of *Dermacentor*.

Dermacentor auratus Supino.

Dermacentor auratus Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 235 (♂♀, Carin Chebà, Mooleyit (Tenasserim), off "*Ursus torquatus*" = *Euarctos thibetanus thibetanus, Sus cristatus;* type in Genoa M.); 1897, *Op. cit.*, (2) **3**, pt. 2, pp. 250–251, Pl. 13, fig. 14.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After studying numerous specimens from India, Burma, Malaya, Siam, Sumatra, Java, New Guinea and the Philippine Islands, I can recognize with certainty only *D. auratus* Supino. The status of the other species and subspecies described by Neumann and Schulze can not be settled definitely at this time; not only are their descriptions meager and insufficient, but illustrations are lacking or inadequate in the essential characters necessary for accurate determination. Due to the known, great variation in this genus, the only reliable characters to which some significance can be attached are the spurs on coxa I, and it is possible that this structure varies also. Only detailed breeding experiments will settle this problem of variation and definitely decide the number of valid species in this area.

The following descriptions are based upon specimens in the collections studied. It was felt advisable to include the description and figures of males (Fig. 10A–F) collected near the type locality in Burma, and these are regarded as typical *auratus*. The single male (Fig. 11A–F) from Medan, Sumatra, probably represents a variation of *auratus*. Only one female (Fig. 10G–M) from Medan, Sumatra, was found to agree closely with specimens collected near the type locality, and it is regarded as typical *auratus*. Three females (Fig. 11G–M) from Sumatra and one female (Fig. 12A–G) from Java probably also represent variations of *auratus*.

Male (Fig. 10A–F). Scutum of two Burma specimens respectively 4.2 and 4.5 mm. long by 3.6 and 4.2 mm. wide, oval, narrowed anteriorly, widest at mid-length; brown markings all more or less raised; pseudoscutum delimited by a series of fused, raised, brown stripes; lateral margins partially set off by ocular stripe and paramedian stripes fused to form a long, narrow stripe; posterior margin set off by a transverse stripe and two antero-accessory stripes set at right angles to it; para-median stripes fused with antero-accessory stripes to complete lateral border; antero-accessory stripes extending a short distance behind transverse stripe; a long, median, longitudinal stripe beginning near anterior margin of

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Fig. 10. *Dermacentor auratus* Supino; typical. A–F, male from Burma: A, scutum; B, coxae I–IV; C, tarsus IV; D, capitulum in dorsal view; E, same in ventral view; F, spiracle. G–M, female from Sumatra: G, scutum; H, coxae I–IV; I, tarsus I; J, tarsus IV; K, capitulum in dorsal view; L, same in ventral view; M, spiracle.

scutum, passes through transverse stripe and continues posteriorly a short distance; postero-median stripe short, nearly reaching median longitudinal stripe; postero-accessory stripes beginning in vicinity of third and fourth festoons, extended anteriorly a short distance and curving toward postero-median stripe; lateral spots very weak, indistinct; a dark brown, irregularly thickened band, beginning in region of eye, outlines margin of scutum and extends posteriorly to first festoon; punctations numerous and unequal; larger ones circular, deep and uniformly distributed; smaller ones numerous, but inconspicuous; punctations lacking on all dark brown, raised areas; cervical grooves deep and comma-shaped anteriorly, continued as shallow depressions posteriorly; lateral grooves as a single row of large punctations beginning a short distance behind eyes; festoons longer than broad and separated by a deep, wide groove; festoons with varying amounts of white ornamentation, third and fourth festoons on each side with least amount. Ventral body surface lighter and with a few, fine hairs; genital opening opposite coxa II; anal opening opposite spiracles; genital grooves nearly parallel, but widely divergent around anal opening; spiracles comma-shaped and small. Legs large, strong, thick, ornate and punctate; coxa I with two widely separated, short, blunt spurs, with internal spur slightly wider; coxae II and III with two subequal, widely separated, short, blunt spurs; coxa IV nearly twice as large as other coxae, with one external spur, and one to four internal spurs; tarsus I with a long, proximal part and a short, distal part; tarsus IV tapering gradually, with three ventral spurs; pulvillus long. Capitulum 1.0 mm. long by 0.8 mm. wide; basis and palps ornate dorsally and finely punctate; basis rectangular and about twice as wide as long; cornua short and broad; palpal articles two and three nearly equal; article one only barely visible dorsally, being concealed by a retroverted prominence of article two; ventrally article I with a large, triangular plate bearing several hairs; hypostome short; 3:3 dentition, with about nine to twelve teeth per file.

Female (Fig. 10G–M). A single, Sumatra specimen 4.95 mm. long by 4.6 mm. wide, exclusive of capitulum, partially engorged, nearly oval, narrows slightly posterior to eyes and is widest at midlength. Scutum 2.1 mm. long by 2.5 mm. wide, slightly wider than long and widest at anterior third; all brown markings without punctations; a broad, dark brown margin, beginning as an ocular spot, continues completely around posterior margin of scutum; median stripe long, extending nearly to top margin of scutum; cervical stripes on each side of median stripe bow-shaped, distinct and not reaching lateral margin of scutum; larger punctations numerous and deep; smaller punctations in scapular and posterior regions; very fine punctations uniformly distributed over scutum; cervical grooves deep and convergent anteriorly, but less so posteriorly; scutum with pronounced depression in region of cervical grooves; eyes flat and dark. Dorsal body surface with many, large punctations from each of which arises a thick, white, appressed hair; marginal groove long, distinct, including three festoons and a portion of fourth on each side; postero-median groove nearly reaching scutum; para-median grooves about one-half length of median groove and obliquely placed; festoons distinct and slightly longer than wide; white hairs in or near each groove separating festoons. Abdomen ventrally lighter in color, with a few short, white hairs in region of genital aperture; genital opening opposite coxa II; anal opening opposite spiracles; genital grooves nearly parallel, but diverging widely anterior to anal opening; spiracle triangular, with blunt angles. Legs brown, strong and thick, ornate, with white markings on dorsal surface of third and fourth pairs more pronounced; coxa I with two, short, obtuse, well separated spurs; internal about twice as wide as external; coxae II and III with two, shorter spurs, more widely separated than those of coxa I; coxa IV with two short, sharp, nearly equal, and widely separated spurs having a very tiny spur between them; tarsi II–IV tapering gradually and with three distinct, ventral spurs; pulvillus long. Capitulum 1.3 mm. long and 0.9 mm. wide; enamel marking on basis and palps; basis rectangular, with lateral margins slightly convex; cornua distinct; porose areas oval, deep and with interval between them slightly less than their diameter; palps relatively long; article two longer than article three; article one very small, partly fused with article two, only partially visible dorso-laterally; ventrally with a large, prominent, triangular plate bearing three, long hairs on inner margin; hypostome short, lateral margins nearly parallel and dentition 3:3, with approximately fourteen to fifteen teeth per file.

Male, variation (Fig. 11A–F). Unengorged Sumatra specimen, exclusive of capitulum, 3.9 mm. long by 3.0 mm. wide, oval, narrowed anteriorly and widest just anterior to spiracles, blackish-brown with pale, enamel markings; pseudoscutum slightly raised

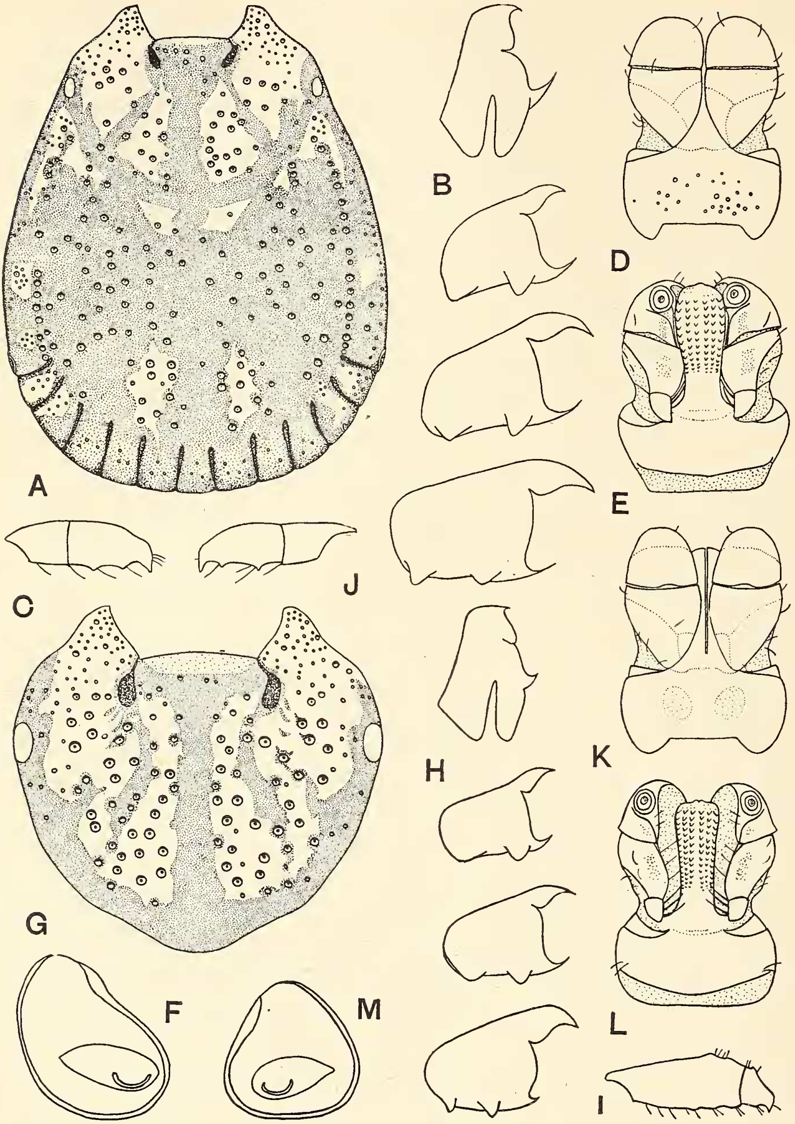


Fig. 11. *Dermacentor auratus* Supino; variation from Sumatra. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, capitulum in dorsal view; E, same in ventral view; F, spiracle. G–M, female: G, scutum; H, coxae I–IV; I, tarsus I; J, tarsus IV; K, capitulum in dorsal view; L, same in ventral view; M, spiracle.

above scutum proper; punctations numerous and unequal, with finer punctations in scapular regions; cervical grooves as short, deep punctures; eyes small and dark yellow; lateral groove as a series of linearly arranged punctations, not including any festoons; first two festoons on each side partially covered with white enamel, other festoons without enamel. Ventral body surface dark; posterior portion with many large, closely set punctations and long, white hairs; genital opening opposite coxa II; anal opening opposite posterior border of spiracles; spiracles large and comma-shaped; genital groove widely divergent around anal opening. Legs, dark, strong, enameled and finely punctate; coxa I with two relatively long spurs, external spur narrower than internal; coxae II and III with two short, separated and subequal spurs; coxa IV not much larger than others and with two nearly equal, separated and triangular spurs. Capitulum 1.05 mm. long; palps short; article two slightly longer than article three; hypostome short; dentition 3 : 3, with approximately twelve teeth per file.

Female, variation (Fig. 11G–M). Scutum of three engorged, Sumatran specimens respectively 1.96, 2.1 and 2.17 mm. long by 2.24, 2.31 and 2.59 mm. wide, reddish-brown, with white enamel markings, antero-lateral margin excavated to receive legs, and posterior margin slightly sinuous; larger punctations deep and conspicuous; smaller punctations more numerous in scapular angles; cervical grooves short, deep and convex externally; eyes large, yellow and oval. Abdomen uniformly covered with large, deep punctations; marginal groove distinct, deep, including first three festoons on each side; festoons slightly longer than wide, with a few punctations on anterior half. Abdomen ventrally punctate and with short, white hairs; genital opening opposite coxae II; anal opening opposite spiracles; spiracles triangular, with blunt, rounded angles. Tarsus I long, broad and swollen, ending in a single, short spur; tarsi II–IV slender, tapering gradually, with three distinct ventral spurs; coxa I with two very long, closely set spurs, internal broader; coxae II–III with two short spurs, the internal ridge-like; coxa IV with two short, pointed spurs. Capitulum 1.28 mm. long; basis rectangular; cornua distinct; porose areas large and divergent anteriorly; hypostome slender; dentition 3 : 3, with approximately thirteen teeth per file.

Female, variation (Fig. 12A–G). Single, engorged, Java specimen 7.5 mm. long by 6.0 mm. wide, exclusive of capitulum. Body dark brown, oval and widest at region of spiracles. Scutum slightly broader than long, 2.1 mm. long by 2.55 mm. wide, reddish-brown, with extensive yellow-white enamel; larger more numerous punctations deep and circular; finer punctations in scapular regions, with very few in posterior portion; punctations not present on brown markings; cervical grooves as deep punctures anteriorly; eyes long, flat and dark brown. Abdomen punctate, with a long, white, conspicuous hair in each punctation; marginal groove narrow; festoons prominent and longer than wide; genital opening opposite coxa two; anal opening opposite posterior border of spiracles; spiracles triangular, with rounded angles. Legs strong, dark brown and covered with enamel; coxa I with two long spurs, external long, narrow and tapering, internal broader and quadrangular; coxae II, III, and IV each with two short, subequal, widely separated spurs; tarsus I with a short, ventral spur; tarsi II–IV long, tapering gradually, with three ventral spurs; pulvillus about one-half as long as claws. Capitulum 1.26 mm. long by 0.72 mm.

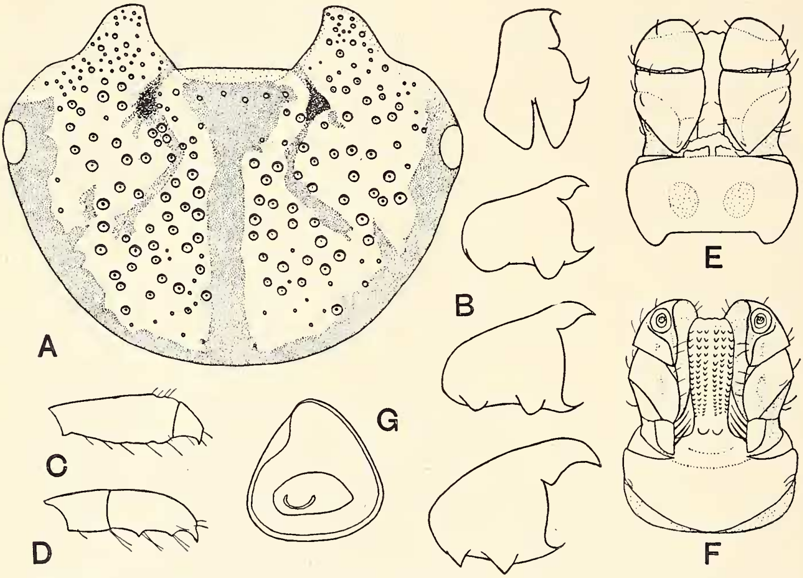


Fig. 12. *Dermacentor auratus* Supino, female; variation from Java: A, scutum; B, coxae I–IV; C, tarsus I; D, tarsus IV; E, capitulum in dorsal view; F, same in ventral view; G, spiracle.

wide; basis rectangular, with rounded sides; cornua distinct; porose areas large, oval and slightly divergent; article two longer than article three; hypostome with 3:3 dentition, with approximately fifteen to seventeen teeth per file.

Biology. The United States Army Typhus Commission collected many nymphs of *auratus* in Burma and reared them to the adult stage. These were taken off *Viverricula indica thai, Rattus rattus, Cervus unicolor, Callosciurus quinquestriatus quinquestriatus, Callosciurus sladeni midas, Ratufa gigantea gigantea, Gallus gallus gallus,* man, guinea pig and monkey. Adults were taken off *Arctonyx collaris, Felis tigris, Sus cristatus* and *Callosciurus quinquestriatus quinquestriatus.*

This species is also found on wild and domestic pigs. Though larvae have been recorded by Sharif in 1928 off man and deer and assigned to this species, they were neither described nor illustrated. This species normally attacks wild animals, but its occurrence on domestic animals and on man makes it a potential disease vector.

Distribution and Hosts. This species is definitely known from India, Burma and Sumatra. Other records of *Dermacentor,* described under various specific names, require further study, and for this reason have been omitted from this work. All specimens studied were taken off domestic pigs.

Genus *Rhipicephalus* C. L. Koch, 1844

Key to Species of *Rhipicephalus*

Males

1. Anal plates triangular, with internal margin only slightly concave .... *R. sanguineus*
   Anal plates sickle-shaped, with internal margin very concave; external and posterior margins forming a regular curve 2
2. Scutum smooth. Hairs small and inconspicuous.
   R. haemaphysaloides haemaphysaloides
   Scutum rough and irregular. Hairs larger and more conspicuous .... *R. haemaphysaloides pilans*

Females

1. Scutum elongate-oval, longer than wide and usually somewhat produced posteriorly. Punctations on scutum numerous, close set, irregularly distributed. Legs slender.
   R. sanguineus
   Scutum about as wide as long. Punctations on scutum unequal;

finer ones seen only with higher magnification. Legs stout. 2

2. Punctations on scutum less coarse. Hairs small and inconspicuous. Abdomen with weak hairs, sparsely distributed. *R. haemaphysaloides haemaphysaloides*

Punctations on scutum coarser. Hairs larger and more conspicuous. Hairs on abdomen numerous, long thick and appressed .... *R. haemaphysaloides pilans*

Rhipicephalus haemaphysaloides Supino.

This species is divided into two subspecies, *Rhipicephalus haemaphysaloides haemaphysaloides* Supino and *Rhipicephalus haemaphysaloides pilans* Schulze, which form two distinct, geographical units. Zumpt in 1943 noted the presence of transitional specimens between the two subspecies on the island of Sumatra; he decided that these transitional forms belonged to *R. haemaphysaloides pilans* and named the Straits of Malacca as the boundary dividing the two subspecies. I saw numerous specimens from eleven localities in Sumatra, and I also found transitional specimens. Those from Upper Sumatra are closely allied to the typical form found in Burma, and those from Lower Sumatra are more closely allied to *pilans*. All of Zumpt's specimens probably came from Lower Sumatra. Both subspecies definitely occur in Sumatra and each is restricted to a definite portion of the island. The boundary between the two subspecies is not the Straits of Malacca, but it is somewhere between Upper and Lower Sumatra. Since no specimens were collected in Central Sumatra, the complete range of each subspecies in this region can not be determined at this time. On no other island in this area are both forms known to occur.

Rhipicephalus haemaphysaloides haemaphysaloides Supino.

Rhipicephalus haemaphysaloides niger Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 234 (♀, Yado, Burma; type in Genoa M.). Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 46 (*incertae sedis*).

Rhipicephalus haemaphysaloides ruber Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, pp. 234–235 (♂, ♀; Mt. Mooleyit, Tenasserim; Meteleó, Thagatà, Juva, Cagó del Cadù Gianng, N.E. of Bomo, Burma; cotypes in Genoa M.); 1897, *Op. cit.*, (2) **3**, pt. 2, p. 250, Pl. 12, figs. 10–11 (♂, ♀).

Rhipicephalus paulopunctatus Neumann, 1897, Mém. Soc. Zool.

France, **10,** pp. 397–398, 419, 420 (1 ♂, 1 ♀, Indrapoera, Sumatra; cotypes described from Hamburg M., now lost) [in part: *nec* male = *R. sanguineus*]; 1901, *Op. cit.*, **14,** p. 273 (11 ♂, 15 ♀, Canton and Fumni, China). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 418. Neumann, 1902, Arch. de Parasit., **6,** pt. 1, p. 121 (♀, Ceylon, off *Bos taurus*).

Rhipicephalus haemaphysaloides Neumann, 1897, Mém. Soc. Zool. France, **10,** p. 417 (Yado, Burma); 1902, Arch. de Parasit., **6,** pt. 1, pp. 125–126 (description from types, 3 ♂, 1 ♀); 1904, *Op. cit.*, **8,** pt. 3, p. 454 (Java and Ceylon) [Java record doubtful]. Warburton, 1907, Bull. Imper. Dept. Agric. India, No. **6,** pp. 10–11, fig. 15 [*nec* fig. 14] (♂, ♀, Moradabad, United Provinces; Chin Hills, Burma, off goat, dog, sheep, cattle); 1907, Journ. Econ. Biol., **2,** pt. 3, p. 93 (variability in males). Neumann, 1908, Notes Leyden Mus., **30,** p. 83 (in key to males). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 103. Warburton, 1910, Parasitology, **3,** pt. 4, p. 396 (Zool. Gardens, Calcutta, other localities, off *Felis marmorata*). Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, p. 41 (distributed as two subspecies). Patton and Cragg, 1913, Textbook Medical Ent., pp. 598, 601, Pl. 73, fig. 9, Pl. 77, fig. 6 (Madras). Warburton, 1925, Spolia Zeylanica, **13,** pt. 2, p. 255 (Colombo, Ceylon, off bear, dog and leopard). Sharif, 1928, Records Indian Mus., **30,** pt. 3, pp. 280–283, fig. 26, Pl. 8, figs. 3–4 (extensive distribution and host lists from Burma and India); 1930, *Op. cit.*, **32,** pt. 2, pp. 111–112, Pl. 3, fig. 8 (♀, teratological specimen). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 140, 142, map 2 [in part: Upper Sumatra record only]; 1932, Veeartsenijk. Meded., No. 79, pp. 10, 32, fig. 7, map 2 [in part: Upper Sumatra record only]. Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pts. 2–3, pp. 514, 523 (morphological); 1932, Sitz.-Ber. Abhand. Naturf. Gesellsch. Rostock, (3) **3,** p. 117 (morphological); 1935, Wissenschaftliche Ergebnisse Exped. Karakorum, Zool., Acarina, Ixodoidea, p. 180 (in key to males); 1936, Zeitschr. f. Parasitenk., **8,** pt. 5, pp. 522–523. Sharif, 1938, Indian Journ. Vet. Sci. and Anim. Husb., **8,** pt. 4, pp. 356, 363, 364 (disease transmission). Schulze, 1939, Zeitschr. f. Parasitenk., **10**, pt. 6, p. 728 (Burma). Strickland, 1939, Indian Journ. Med. Res., **27**, pt. 1, pp. 251–252 (Bhawali Ramgarh, off man). Zumpt, 1943, Zeitschr. f. Parasitenk., **13**, pt. 1, pp. 4, 20. Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 38–40, 84, Pls. 16–19 (♂, ♀, Indochina, off Banteng, deer, dog, *Sus cristatus*, hare). Finnegan, 1945, British Mus., Econ. Series, No. **16**, pp. 46, 47, figs. 18–19.

Rhipicephalus ruber Neumann, 1897, Mém. Soc. Zool. France, **10**, p. 418.

Rhipicephalus (*Eurhipicephalus*) *haemaphysaloides* Neumann, 1904, Arch. de Parasit., **8**, pt. 3, p. 449.

Rhipicephalus (*Eurhipicephalus*) *haemaphysaloides* var. *paulopunctata* Neumann, 1904, Arch. de Parasit., **8**, pt. 3, p. 449.

Rhipicephalus haemaphysaloides var. *expedita* Neumann, 1904, Arch. de Parasit., **8**, pt. 3, pp. 454–455 (♂, ♀, China, Sumatra).

Rhipicephalus haemaphysaloides haemaphysaloides Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 41, fig. 21 (♂, ♀, China, Burma, Ceylon, Java, Borneo, Sumatra, off *Bos taurus*) [Java, Borneo records doubtful]. Schulze, 1936, Zeitschr. f. Parasitenk., **8**, pt. 5, p. 522 (Burma). Zumpt, 1940, Zeitschr. f. Parasitenk., **11**, p. 674; 1943, *Op. cit.*, **13**, pt. 1, pp. 4, 5, 6, 20–22, figs. 20–21 (♂, ♀, India, So. China, Formosa, off *Rhinoceros sondaicus, Bos taurus, Canis familiaris* and *Rusa unicolor*).

Rhipicephalus haemaphysaloides expeditus Neumann, **1911**, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 41 (♂, ♀, China, Sumatra, off "*Buffelus indicus*" = *Bos bubalis bubalis*).

Rhipicephalus haemaphysaloides paulopunctatus Schulze, **1936**, Zeitschr. f. Parasitenk., **8**, pt. 5, pp. 522, 523 (1 ♂, Liangas, Sumatra; 2 ♀, Lubok Paku, Sumatra, off tiger).

Male (Fig. 13A–G). Thirty Sumatra specimens range from 3.9 to 2.9 mm. long by 2.64 to 1.8 mm. wide, exclusive of capitulum; average 3.38 mm. long by 2.16 mm. wide. Body elongate-oval, about one and a half times as long as wide, tapering toward anterior end, with marked indentation in region of eyes, widest opposite spiracular plates, reddish-brown to black; larger punctations few and evenly distributed, with a small, white hair issuing

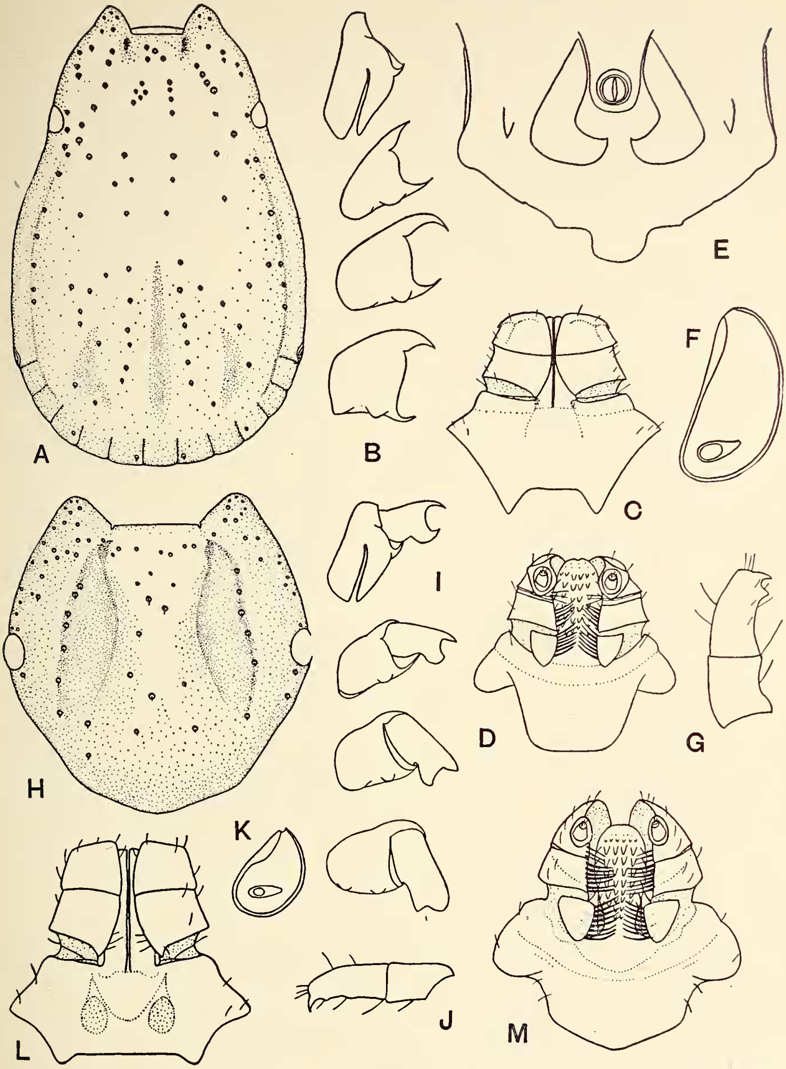


Fig. 13. *Rhipicephalus haemaphysaloides haemaphysaloides* Supino. A–G, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, same in ventral view; E, ventral view of scutum, showing anal and adanal plates; F, spiracle; G, tarsus IV. H–M, female: H, scutum; I, coxae I–IV; J, tarsus IV; K, spiracle; L, capitulum in dorsal view; M, same in ventral view.

from each; finer punctations very numerous, but discernible only under higher magnification; cervical grooves short, deep and slightly convergent; lateral grooves as furrows in hind part, with large punctations linearly arranged in each; median groove long and narrow; paramedian grooves diagonal; eyes prominent, yellow, flat and elongate-oval; festoons protruding in engorged specimens; median festoon as a pronounced, caudal protrusion; body ventrally with numerous, large, white hairs; spiracular plates large and comma-shaped; genital opening opposite coxa II; anal opening opposite border of spiracular plate; anal plates sickle-shaped and heavily chitinised; adanal plates small, less chitinised and weakly developed. Legs stout and covered with long, white hairs; coxae large and conspicuous; coxa I with two large spurs, internal about twice as broad as external; coxae II and III with a short, external spur and a broad, ridge-like, scarcely visible, internal spur; coxa IV with internal and external spurs weakly developed; tarsus IV tapering gradually, ending in a terminal and subterminal spur. Basis capituli hexagonal, about twice as wide as long and salient laterally; cornua prominent and strongly projecting; palpal articles two and three together slightly longer than broad; distinct, lateral edge on palpal article three; article one with a distinct, ventral plate containing six to nine large, white hairs; article two with a similar fringe, but with less hairs; article three with a very short, ventral spur; hypostome small; 3:3 dentition, with approximately nine to ten teeth per file.

Female (Fig. 13H–M). Thirty unengorged, Sumatra specimens from 3.96 to 3.12 mm. long by 2.4 to 2.04 mm. wide, exclusive of capitulum; average 3.48 mm. long by 2.24 mm. wide; largest female 19.2 mm. long by 14.1 mm. wide. Body elongate-oval, about one and a half times as long as broad. Scutum slightly longer than wide, reddish-brown to black, posterior margin sinuous; cervical grooves deep and diagonal; well developed furrows, leading from cervical grooves, bow-shaped and divergent posteriorly; large punctations conspicuous, more or less linearly arranged, with a short, white hair projecting from each; eyes as in male. Abdomen dorsally with small, thin, white hairs; spiracular plate nearly as wide as long, with a short, curved extension; body ventrally with numerous, short, white hairs and occasional longer ones; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate. Legs similar to those of male; coxae also similar, but internal spur of coxa IV not very distinct. Capitulum more than twice as wide as long; cornua not as strong as in male; porose areas oval and slightly divergent anteriorly; palpal articles two and three together much longer than wide; article three with blunt angle on outer edge; ventral surface of capitulum as in male; hypostome dentition 3:3, with approximately nine teeth per file.

Distribution and Hosts. Known from India, Burma, Ceylon, Indochina, southern China, Formosa. It is known in the East Indies from Upper Sumatra (Neumann, 1897, 1904, 1911; Krijgsman and Ponto, 1931, 1932; Schulze, 1936). The following records from Sumatra are based on specimens seen in the Kraneveld collection: Koetaradja, off buffalo and cow; Lhokseumawe, off buffalo, cow and dog; Medan, off buffalo, cow, goat, pig and without host stated; Padangsidimpoean, off buffalo, cow, dog and pig; Goenoengtoea, off buffalo. Numerous specimens from Burma were seen in the Rocky Mountain Laboratory taken off the following hosts: *Muntiacus muntjak vaginalis, Arctonyx collaris, Hystrix subcristatus subcristatus, Cervus unicolor, Felis tigris, Felis pardus, Gallus gallus gallus* and Orange-breasted Flycatcher. A survey of the native fauna of Upper Sumatra would probably show a similarly wide host range.

Biology. This species is indigenous to the Oriental Region and is found on a wide variety of native animals. Introduced domestic animals have proven to be suitable hosts, and the conditions of domestic life have hastened and facilitated the spread of this tick throughout the Oriental Region. It is second in importance to *Boophilus microplus* as a pest of livestock. Little is known about disease transmission by this species, but it should be regarded with suspicion as a possible vector.

Though there are hundreds of records of this species taken in various localities, the larvae and nymphs have never been observed. In the large Kraneveld collection not one immature stage was found, and in the extensive survey made by the United States Typhus Commission in Myitkyina, Burma, no young forms were collected. It must be assumed that this is either a two-host tick or a three-host tick spending part of its life cycle on other animals, probably small rodents or birds.

Rhipicephalus haemaphysaloides pilans Schulze.

Rhipicephalus pilans Schulze, 1935, Wissenschaftliche Ergebnisse Exped. Karakorum, Zool., Acarina, Ixodoidea, p. 180 (description of male in key); 1936, Zeitschr. f. Parasitenk., **8**, pt. 5, p. 524, figs. 3–5 (2 ♂, Rana Mêsé, Flores; **1**, ♀.

Badjawa, Flores; 1 ♀, Swela, Lombok; holotype ♂ in Zool. M. Berlin).

Rhipicephalus haemaphysaloides Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 142, map 2 (distribution and hosts in Indonesia) [in part: not Upper Sumatra records]; 1932, Veeartsenijk. Meded., No. **79**, pp. 10, 32, fig. 7, map 2 (♂, ♀, Lower Sumatra, Java, Madoera, Soembawa, Soemba, Sawoe, Timor, Alor, Roti, Borneo, off buffalo, cows, goats and dogs).

Rhipicephalus haemaphysaloides paulopunctatus Schulze, 1932, Sitz.-Ber. Abhand. Naturf. Gesellsch. Rostock, (3) **3**, p. 116, fig. 13 (♂, Java). Anastos, 1948, Psyche, **55**, pt. 1, pp. 36–37 (♀, Java, on another tick, *B. microplus*).

Rhipicephalus haemaphysaloides pilans Zumpt, 1940, Zeitschr. f. Parasitenk., **11**, p. 675; 1943, *Op. cit.*, **13**, pt. 1, pp. 5, 6, 22–23, figs. 22–24 (♂, ♀, Greater and Lesser Sunda Islands, off "*Sus vittatus*" = *Sus cristatus vittatus*, "*Buffelus bubalus*" = *Bos bubalis bubalis, Bos taurus* and *Felis tigris*).

Male (Fig. 14A–D). Thirty Java specimens average 3.09 mm. long by 2.09 mm. wide, exclusive of capitulum. Darker forms seen more frequently than lighter ones. Readily distinguished from *R. haemaphysaloides haemaphysaloides* by its rugose and coarsely sculptured scutum; much deeper median and paramedian grooves; very typical, thick, appressed, white hairs. In other features agrees very closely with typical form.

Female (Fig. 14E–J). Thirty unengorged, Java females from 3.45 to 3.07 mm. long by 2.25 to 2.1 mm. wide, exclusive of capitulum; average 3.19 mm. long by 2.8 mm. wide; largest, engorged specimen 18 mm. long by 12.5 mm. wide. Sculpturing of scutum similar to male; conspicuous, white hairs in each, deep punctation; finer punctations more clearly visible than in typical form. Very characteristic covering of heavy, white, appressed hairs on abdomen. Resembles otherwise closely female of typical form.

Distribution and Hosts. Known from Lower Sumatra, Madoera, Soembawa, Soemba, Sawoe, Roti, Timor, Alor, Celebes and Borneo (Krijgsman and Ponto, 1931, 1932), Flores, Lombok (Schulze, 1936), Java (Krijgsman and Ponto, 1931, 1932; Anastos, 1948). Numerous specimens were seen in the Kraneveld collection from Sumatra (Loeboeklinggau, off buffalo; Palembang, off cow; Benkoelen, off buffalo, cow and dog; Lahat, off cow; Tandjoengkarang,

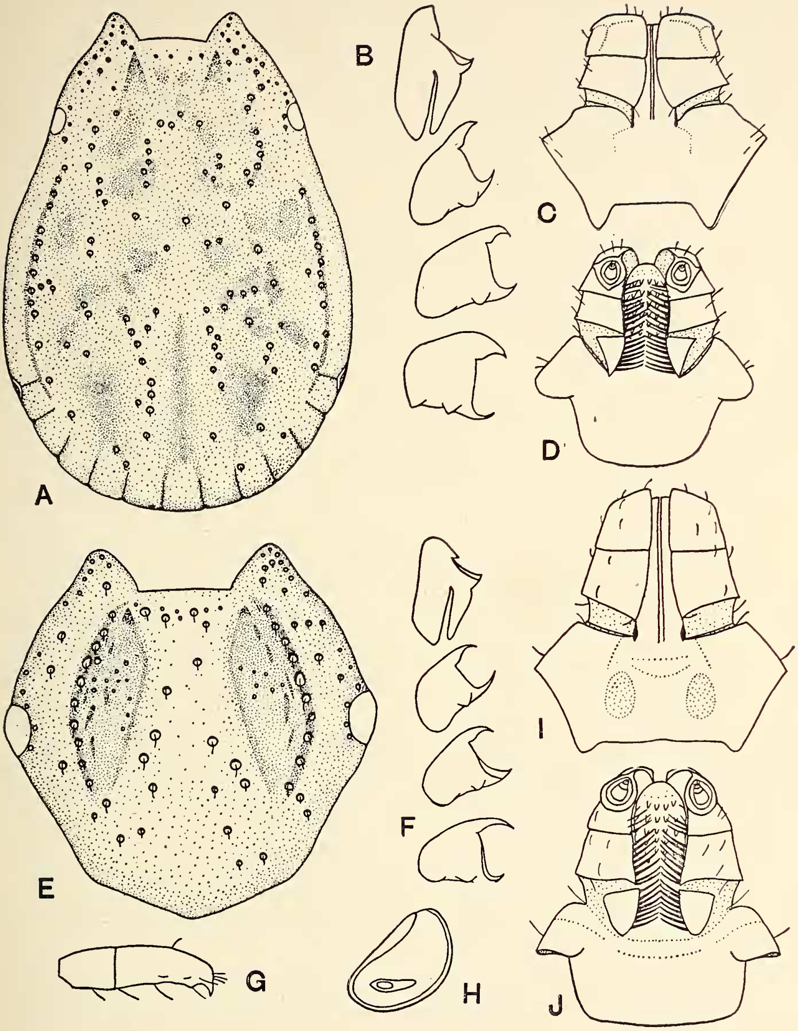


Fig. 14. *Rhipicephalus haemaphysaloides pilans* Schulze. A–D, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, same in ventral view. E–J, female: E, scutum; F, coxae I–IV; G, tarsus IV; H, spiracle; I, capitulum in dorsal view; J, same in ventral view.

off buffalo, dog and goat), Java (Serang, off sheep; Batavia, off buffalo and cow; Buitenzorg, off buffalo and cow; Tegal, off dog; Madioen, off cow; Bodjonegoro, off buffalo and sheep; Djember, off pig), Madoera (Pamekasan, off cow; Soemenep, off buffalo, cow, goat, and horse), Bali (Singaradja, off cow and horse), Soembawa (Soembawabesar, off buffalo), Soemba (Waingapoe, off buffalo, cow and dog), Celebes (Watampone, off buffalo; Sengang, off goat; Parepare, off buffalo, cow, dog and sheep; Makale, off buffalo and dog). Numerous specimens were seen from the Philippine Islands in the collection of the Rocky Mountain Laboratory. Most of the records are from domestic animals, with a few from wild animals. It is likely that the host list for this subspecies will prove to be as extensive as that of the typical form.

Rhipicephalus sanguineus (Latreille).

Ixodes sanguineus Latreille, 1806, Gen. Crust. Ins., **1**, p. 157 (no sex, France, no host).

Rhipicephalus sanguineus C. L. Koch, 1844, Arch. f. Naturgesch., **10**, pt. 1, p. 238 (merely lists species). Nieschulz, 1924, Tijdschr. v. Diergeneesk., **51**, p. 195 (Sumatra, off native cattle). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, p. 141, map 2 (Java, Soemba, Madoera, Sumatra, Timor, Alor Island, Amboina and Saparoea, off man, cattle, dog, buffalo); 1932, Veeartsenijk. Meded., No. **79**, pp. 8–10, 32, figs. 5–6, map 2 (♂, ♀, hosts, distribution in Indonesia).

Rhipicephalus sanguineus sanguineus Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 35–36, figs. 16–17 (world-wide distribution, including Sumatra and Java).

? *Rhipicephalus rubicundus* Frauenfeld, 1867, Verhandl. Zool. Bot. Gesellsch. Wien, **17**, p. 462 (♂, taken aboard ship in Sunda Sea).

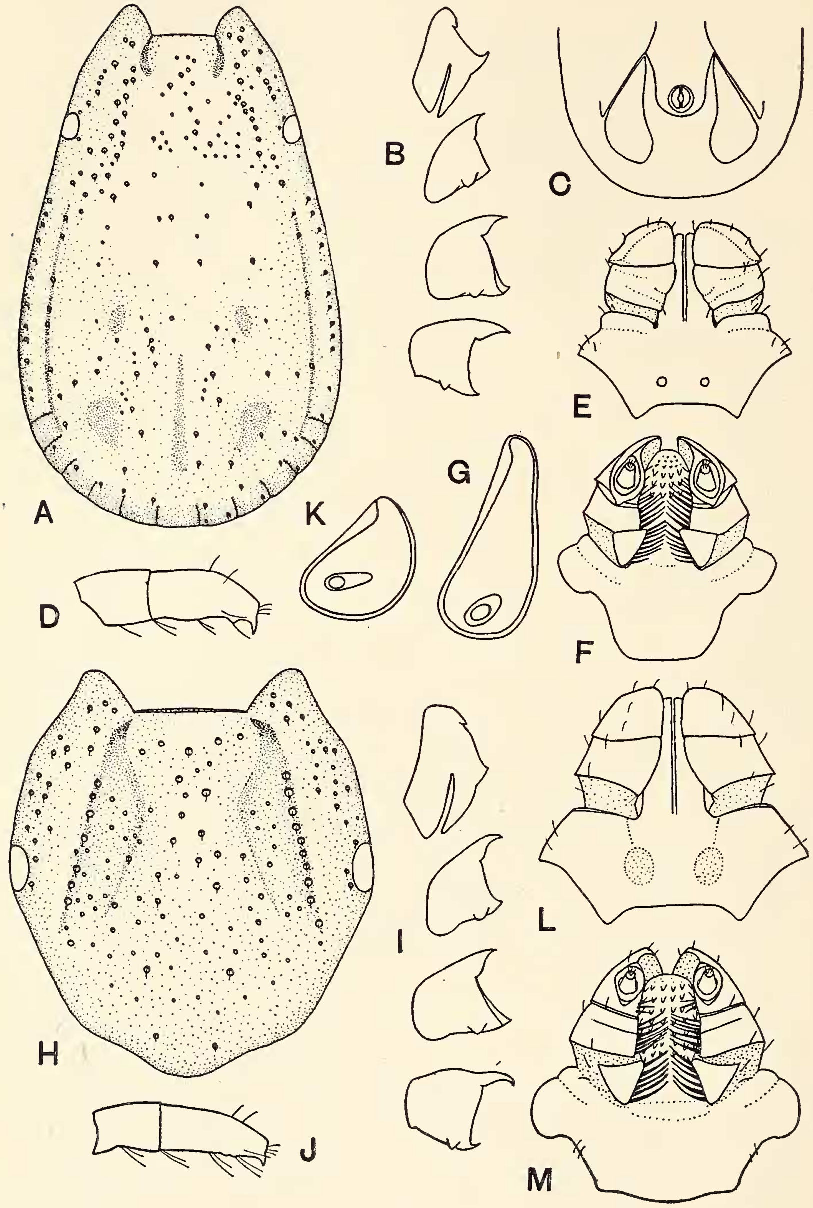
Because of its wide distribution this species has been the subject of much discussion; only references to the original description and to the East Indies are included here.

Male (Fig. 15A–G). Twenty Java specimens from 2.31 to 2.25 mm. long by 1.36 to 1.35 mm. wide, exclusive of capitulum; average 2.28 mm. long by 1.35 mm. wide. Body elongate-oval, widest near region of spiracles, reddish-brown; punctations more numerous anteriorly, with a very short, inconspicuous hair arising from each;

cervical grooves short, deep and convex externally; median and two paramedian grooves not very deep; a small pit slightly anterior to each paramedian groove; lateral grooves beginning posterior to eyes and including first festoon on each side; eyes oval and slightly convex; festoons about as long as wide, with a few punctations. Ventral body surface lighter than dorsal; spiracles very long and comma-shaped; genital opening opposite coxa II; anal opening opposite spiracles; anal plates triangular and mildly concave on internal border; adanal plates short, sharp points. Legs short, thick and hirsute; coxa I with two long, closely-set spurs, internal broader; coxae II and III with a very short, external spur, inner corner salient; coxa IV with very short, internal and external spurs; tarsus I long, without ventral spurs and sloping gradually; tarsi II–IV shorter, with a strong, ventral, terminal spur and a subterminal spur. Capitulum 0.51 mm. long; basis hexagonal, lateral edges salient, posterior margin nearly straight; cornua distinct; article I ventrally with a distinct plate; long hairs on articles I and II; hypostome short; dentition 3:3, with seven to eight teeth per file.

Female (Fig. 15H–M). Ten unengorged, Java specimens from 2.55 to 2.1 mm. long by 1.65 to 1.35 mm. wide, exclusive of capitulum; largest, engorged specimen 10.2 mm. long by 6.6 mm. wide. Reddish-brown scutum 1.2 mm. long by 1.2 mm. wide; punctations large, with a short, white hair in each; cervical grooves long, deep and bow-shaped; eyes large and oval. Abdomen with long, white hairs; marginal grooves distinct, including first three festoons on each side; median and paramedian grooves long and narrow; abdomen ventrally lighter in color and with long hairs; genital opening opposite coxa II; anal opening opposite spiracles; spiracle shorter than in male. Legs long and thin; tarsi and coxae as in male. Capitulum 0.63 mm. long; basis hexagonal, broader than in male; cornua distinct; porose areas small, oval and slightly divergent anteriorly; hypostome dentition 3:3, with approximately ten teeth per file.

Distribution and Hosts. This is probably the most widely distributed of all ticks, being known throughout the world. The known hosts are numerous and include both domestic and wild animals. It is known in the East Indies from Sumatra (Neumann, 1911; Nieschulz, 1924; Krijgsman and Ponto, 1931, 1932), Java (Neumann, 1911; Krijgsman and Ponto, 1931, 1932), Soemba, Madoera, Timor, Alor, Amboina and Saparoea (Krijgsman and Ponto, 1931, 1932). Numerous specimens were seen in the Kraneveld collection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from Sumatra (Lhokseumawe, off goat; Padangsidimpoean, off pig), Java (Tegal, off dog; Semarang, off dog; Toeban, off dog; Madioen, off dog; Bodjonegoro, off dog; Blitar, off dog; Djember, off dog; Bondowoso, off dog), Madoera (Pamekasan, off cow), Bali (Singaradja, off cow, and dog), Soembawa (Soembawabesar, off dog), Celebes (Manado, off cow).

Biology. All stages in the life cycle are known. This tick is implicated in disease transmission both experimentally and naturally. It is capable of transmitting Rocky Mountain spotted fever to experimental animals, and it is a known vector in nature of canine babesiasis and bovine anaplasmosis.

Genus *Boophilus* Curtice, 1891

In 1934 Minning established the subgenera *Uroboophilus* and *Palpoboophilus*. These are based on tenuous characters, and I regard them as synonyms of *Boophilus*.

Boophilus microplus (Canestrini).

Haemophysalis micropla [*sic*] Canestrini, 1888, Atti Soc. Veneto-Trent. Sci. Nat., **11,** pt. 1, (1887), pp. 104–105, 110, Pl. 9, figs. 3, 3a–d and 5, 5a–b (Chaco australe, Paraguay; type in Genoa M.).

Rhipicephalus annulatus Neumann, 1897, [*nec* Say, 1821] Mém. Soc. Zool. France, **10,** p. 412 [in part: only records from Timor, off "*Husa* [sic] *equina*" = *Cervus unicolor equinus*; Sumatra].

Rhipicephalus australis Fuller, 1899, Queensland Agric. Journ., **4,** pt. 5, pp. 389–392, figures on pp. 391, 392 (Australia, off horses and cattle). Koningsberger, 1900, Teysmannia, **11,** pt. 1, pp. 59–61, figs. 1–6 (♂, ♀, n, l, Indonesia).

Boophilus australis Stiles and Hassall, 1901, Circ. **34,** Bur. Anim. Industry, U. S. Dept. Agric., pp. 2–3. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 417, 420, 422, 426–433, figs. 140–151, 153d, 154c, Pl. 80, figs. 114–139. Nieschulz, 1924,

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Fig. 15. *Rhipicephalus sanguineus* (Latreille). A–G, male: A, scutum; B, coxae I–IV; C, abdomen in ventral view, showing anal and adanal plates; D, tarsus IV; E, capitulum in dorsal view; F, same in ventral view; G, spiracle. H–M, female: H, scutum; I, coxae I–IV; J, tarsus IV; K, spiracle; L, capitulum in dorsal view; M, same in ventral view.

Tijdschr. v. Diergeneesk., **51**, p. 195. Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 284–289, figs. 27–30.

Rhipicephalus annulatus var. *australis* Neumann, 1901, Mém. Soc. Zool. France, 14, p. 280 (♂, Borneo, off deer; ♂, Sumatra, off buffalo; ♀, Sumatra; 4 ♂, 2 n, New South Wales, off cattle; ♀, Singapore, doubtfully).

Boophilus microplus Bequaert, 1926, Med. Report H. Rice 7th Exped. Amazon (1924–1925), pp. 168–171, figs. 1–2. Anastos, 1948, Psyche, **55**, pt. 1, pp. 36–37 (Batavia, Java, off cow).

Boophilus annulatus [*nec* Say, 1821] Doeve, 1923, Nederl. Ind. Bladen Diergeneesk., **34**, pt. 1, pp. 4–18, figs. 1–2 (Watampone, Celebes). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 140, 141, map 1; 1932, Veeartsenijk. Meded., No. **79**, pp. 6–7, 32, figs. 3–4, map 1 (♂, ♀, wide distribution in Indonesia, off buffalo, cow, horse, goat, deer, *Cervus unicolor russa*).

Boophilus (*Uroboophilus*) *krijgsmani* Minning, 1934, Zeitschr. f. Parasitenk., **7**, pt. 1, pp. 9, 11, 29–30, 40, figs. 23–24 (♂, ♀, Celebes, Soemba, Java, Borneo, Timor, Sangihe, Sumatra, Soela Island, Bali, New Guinea, off cattle; holotype ♀ in Z. M. Berlin).

Boophilus (*Uroboophilus*) *rotundiscutatus* Minning, 1934, *Op. cit.*, **7**, pt. 1, pp. 9, 10, 30–31, 40, figs. 25–26 (♂, ♀, Celebes, Borneo, Sumatra, Bali, Java, Soemba, Timor, Saparoea, Amboina, off cattle, deer; holotype ♂ in Z. M. Berlin).

Boophilus (*Uroboophilus*) *longiscutatus* Minning, 1934, *Op. cit.*, **7**, pt. 1, pp. 11, 31–32, 40, fig. 27 (♀, New Guinea, Halmahera, Soela Island, off cattle; holotype ♀ in Z. M. Berlin).

There are probably only three species of *Boophilus* in the world, *B. annulatus* (Say), *B. decoloratus* (Koch) and *B. microplus* (Canestrini). The overlapping in their range is due to the introduction of these ticks with livestock from other parts of the world. *B. annulatus* is more or less restricted to the North American continent; *B. microplus* is found in Central America, South America, Australia, the Oriental Region, in the southern part of Florida and in parts of Africa; and *B. decoloratus* is restricted to Africa. After examining specimens of *B. fallax* Minning from South Africa sent to the Museum of Comparative Zoölogy by G. Theiler, I am convinced that this species is a synonym of *microplus*.

All three species are similar in general appearance. The males are easily separated by two reliable characters, the presence or absence of a caudal appendage and the number of files of hypostome teeth. *B. microplus* and *B. decoloratus* each have a distinct caudal appendage which is completely lacking in *annulatus;* this character serves to separate this species from the other two. The dentition which is 4 : 4 in *microplus* and 3 : 3 or at the most 3.5 : 3.5 in *decoloratus* distinguishes these two. The females of the three species are very similar in appearance, but they can be separated by several minor characters in addition to the dentition of the hypostome which follows the pattern of the males.

B. microplus is the only species found in the East Indies; because so much has been written about it, only the most important references and those dealing directly with Indonesia have been included here. It was probably introduced into the East Indies with livestock. Because of the great amount of attention directed toward this economically important species, numerous names and combinations of names have been adopted.

Minning completely ignored the great variation present in this species and created new subgenera and many new species as a result. He used as a diagnostic character the position of the eyes in relation to the scutum. He stated that some occurred with the eyes near the border of the scutum, some with the eyes on the border, and others with the eyes overlapping the border. G. Theiler in 1943 pointed out that the position of the eyes will vary due to the tension brought to bear upon the scutum by the amount of wrinkling, contraction or distension of the alloscutum in immediate contact with the scutum. Minning also used the shape of the coxal spurs to separate species. This character is also variable and I found all gradations in my material. It is obvious that Minning described specimens and not species. The anal plates of the male also vary considerably in shape; this was pointed out by Bequaert in 1926 from a series of specimens taken in Panama.

Fifty-eight lots were seen in the Kraneveld collection consisting of hundreds of specimens from Medan, Sumatra, where both *rotundiscutatus* and *krijgsmani* were described by Minning. In addition, one hundred sixty-four lots consisting of thousands of specimens were seen from other localities in Sumatra, Java, Madoera, Bali, Soemba, Flores Island, Timor and Celebes, and these are *B. microplus.* Specimens seen from the Philippine Islands, Australia, Burma, and India are also *B. microplus;* therefore, I regard *rotundi-*

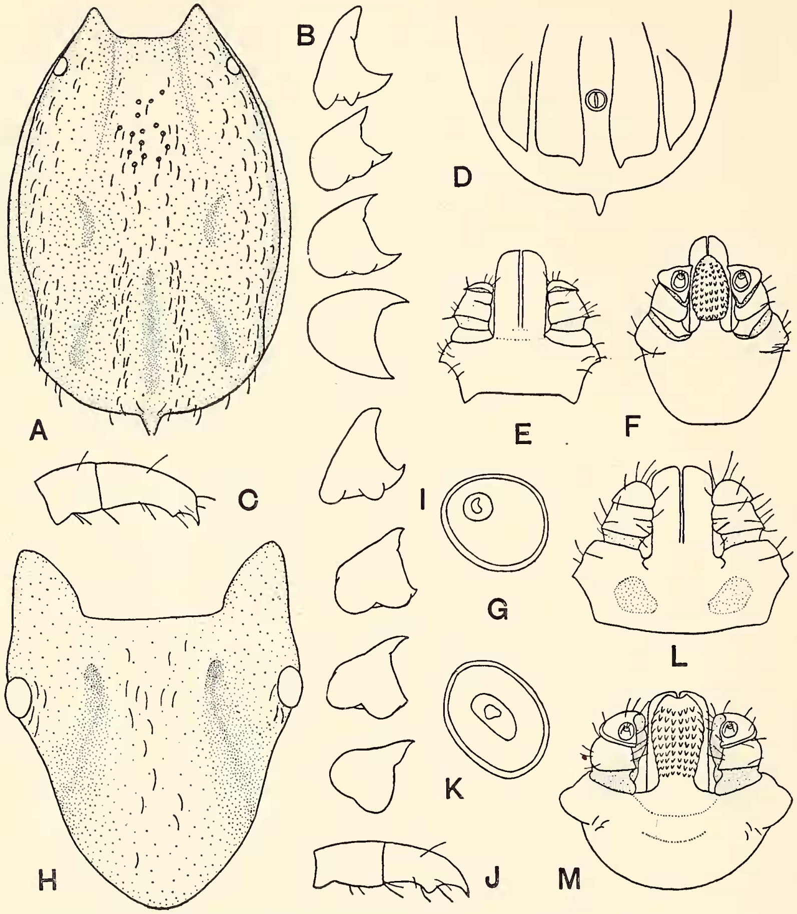

Fig. 16. *Boophilus microplus* (Canestrini). A–G, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, abdomen in ventral view, showing anal and adanal plates; E, capitulum in dorsal view; F, same in ventral view; G, spiracle. H–M, female: H, scutum; I, coxae I–IV; J, tarsus IV; K, spiracle; L, capitulum in dorsal view; M, same in ventral view.

scutatus, krijgsmani and all Minning's other species from the Oriental Region as synonyms of *microplus.*

Male (Fig. 16A–G). Fifty specimens from 2.1 to 1.56 mm. long by 1.35 to 1.02 mm. wide, exclusive of capitulum and caudal appendage; average 1.87 mm. long by 1.17 mm. wide. Body elongate-oval, and widest at mid-length. Scutum not completely covering sides of body, exposed sides finely striate longitudinally; scutum from yellow to reddish-brown; long, narrow, white hairs on all elevated portions, but lacking in grooves and depressed portions; few, medium punctations between cervical grooves; uniformly, finely granulated; cervical grooves shallow, wide, with sub-parallel depressions extending to limit of pseudo-scutum; two shallow, circular depressions posterior to these; postero-median groove wide, deep and without hairs; postero-lateral grooves wide and deep, converging anteriorly toward postero-median groove; eyes small, flat, yellow and inconspicuous; no lateral grooves or festoons; short, wide, caudal appendage narrowing to a sharp point posteriorly. Body ventrally with long, white hairs; genital opening opposite coxa II; anal opening midway between anal plates; anal plates long, punctate, hirsute, terminating posteriorly in a short, internal spur, and in some cases also with a shorter, external spur; adanal plates short, convex externally, punctate, hirsute, terminating posteriorly in a single, sharp point; spiracles nearly circular. Legs short and thick, becoming progressively stouter posteriorly, with numerous hairs dorsally and ventrally; tarsus I long, thick, tapering abruptly; tarsi II–IV shorter, narrower, tapering gradually; tarsus I with one ventral, terminal spur; remaining tarsi each with a terminal and a subterminal spur; claws longer than the pulvillus; coxa I with a very long, narrow, anterior process, visible dorsally and ventrally, and two distinct, triangular spurs, with internal slightly broader than external; in some, spurs equal, in others, internal slightly longer; coxa II with two short, rounded spurs, internal slightly wider than external; coxa III with two spurs similar to coxa II, only shorter; coxa IV without spurs. Capitulum from 0.35 to 0.28 mm. long by 0.49 to 0.42 mm. wide; basis sub-hexagonal, broader than long; cornua short and blunt; palps hirsute and short; articles I, II, and III ventrally with a short, retrograde process; hypostome short; 4:4 dentition, with approximately eight teeth per file.

Female (Fig. 16H–M). Fifty unengorged specimens from 2.4 to 1.8 mm. long by 1.5 to 1.05 mm. wide; average 2.05 mm. long by 1.3 mm. wide; completely engorged female 12 mm. long by 7.5 mm.

wide. Scutum from 0.42 to 0.56 mm. long by 0.35 to 0.49 mm. wide, longer than wide, yellow to brown; punctations absent, but surface finely granulated; cervical grooves long, broad, shallow, continuing to postero-lateral margins of scutum; few, long, white hairs sparsely distributed, but lacking in region of cervical grooves; eyes oval, distinct and slightly raised. Postero-median groove extending about two-thirds the distance toward scutum; postero-lateral grooves nearly as long as median groove; numerous, long, thin, white hairs distributed uniformly over abdomen, but absent in all grooves; no festoons or marginal groove; spiracles nearly circular; genital opening opposite coxa II; anal opening opposite posterior border of spiracle; genital grooves diverging gradually; a broad, shallow, median groove posteriorly from anal opening; numerous, long, white hairs on ventral body surface, but absent in genital and anal grooves. Tarsus I long, slightly swollen at mid-length, ending in a long, distinct, ventral spur; tarsi II–IV long, slender, with a terminal and subterminal spur; pulvillus small, with claws longer; coxa I triangular, longer than wide, with two nearly equal, rounded, separated spurs; coxa II with two nearly equal spurs, but less separated, more broadly rounded and much wider than long; coxa III similar to coxa II; coxa IV with external spur scarcely visible. Capitulum wider than long, from 0.53 to 0.35 mm. long by 0.7 mm. to 0.56 mm. wide; basis hexagonal; porose areas large, oval, widely separated and divergent; cornua absent; article two mildly indented at middle of internal margin, with indentation continued laterally as a groove; hypostome short and broad; dentition 4:4, with seven to eight teeth per file.

Distribution and Hosts. This species, widely distributed in the East Indies, is known from Timor, Sumatra, Borneo, Java, Celebes, Madoera, Bali, Lombok, Soemba, Boetoeng, Soela, Sangihe, Amboina, Saparoea, Tanimbar, New Guinea, Halmahera and Karimoendjowo. Many specimens were seen in the Rocky Mountain Laboratory from the Philippine Islands, Australia, Burma, India, Assam, Nicobar Islands and New Guinea taken off a variety of domestic and wild animals. Two unusual records in this collection are from a buzzard and a domestic chicken.

Thousands of specimens were seen in the Kraneveld collection from Sumatra (Koetaradja, off buffalo, cow and goat; Lhokseumawe, off buffalo, cow and goat; Medan, off buffalo, cow, horse and goat; Padangsidimpoean, off buffalo, cow, goat and pig; Goenoengtoea, off cow; Fort de Kock, off buffalo and cow; Loeboeklinggau, off cow; Palembang, off cow; Benkoelen, off cow; Lahat, off buffalo and cow; Tandjoengkarang, off cow and dog), Nias Island (Goenoengsitoli, off cow), Java (Serang, off cow; Batavia, off buffalo and cow; Buitenzorg, off cow; Poerwokerto, off cow; Tegal, off cow; Magelang, off cow; Semarang, off cow; Toeban, off cow; Ponorogo, off buffalo and cow; Madioen, off cow and dog; Bodjonegoro, off cow; Blitar, off buffalo and cow; Malang, off cow; Pasoeroean, off cow; Probolinggo, off cow; Djember, off cow and pig), Madoera (Pamekasan, off cow and dog), Bali (Singaradja, off cow), Soemba (Waingapoe, off cow), Flores (Roeteng, off buffalo, cow and horse), Timor (Koepang, off cow and dog), Celebes (Makassar, off cow and pig; Watampone, off horse; Singkang, off goat; Parepare, off cow; Makale, off horse; Gorontalo, off cow and horse; Manado, off cow, horse and dog).

Biology. All the stages in the life cycle are known. *B. microplus* is a one-host tick; the larvae attach to the host and remain thereon till mature. They molt on the host, and many adults were found in the Kraneveld collection still within the nymphal skin. They also mate on the host, and many males and females were found in the copulatory condition. Though it is customary for the female to oviposit on the ground after dropping from the host, many vials contained gravid females and hundreds of eggs; whether or not these were ovipositing on the host when collected, can not be said for certain.

Judging from the number of specimens collected in these islands from domestic animals, the species is very abundant and must be a serious pest of livestock. *B. microplus* is known to transmit several diseases in other parts of the world and must, therefore, be regarded as a possible vector in the East Indies. It is known to transmit *Babesia bigemina* (Smith and Kilbourne). This organism is the causal agent of the disease known under several names, Texas cattle fever, red water, splenic fever, bloody murrain, Mexican fever, tick fever, etc. It is also known to transmit bovine anaplasmosis which is caused by *Anaplasma marginale* Theiler.

Genus *Amblyomma* C. L. Koch, 1844

Key to Species of *Amblyomma*

Males[4]

1. Coxa II with two spurs; internal very small. Scutum broad-oval, chocolate-brown with extensive pale markings. Punc-

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[4] Males of *A. cordiferum* and *A. geoemydae* are unknown.

tations numerous and unequal. Hypostome with 4:4 dentition .... *A. robinsoni*

Coxa II with one spur 2

2. Hypostome with 3:3 dentition. Marginal groove present or absent 3

Hypostome with 4:4 dentition. Marginal groove absent 5

3. Coxae II–IV with single, short, triangular spur. Coxa I with two spurs; external nearly three times as long as internal. Marginal groove absent. Scutum ornate, small and subquadrangular. Punctations numerous, unequal and often absent in median area. Eyes small, yellow and often indistinct .... *A. helvolum*

Coxae II–III with single, broad and flat spur. Medium to large ticks 4

4. Medium-sized. Inornate. Marginal groove obsolete or completely absent. Eyes indistinct. Coxa IV with single, broad and flat spur. Coxa I with two short, broad, equal and separated spurs. Punctations unequal and sparsely distributed in periphery; nearly absent in anterior and median areas .... *A. javanense*

Large. Ornate. Marginal groove distinct. Eyes large and slightly bulging. Coxa IV with long, stout spur. Coxa I with two spurs; external pointed and about twice as long as internal. Punctations unequal and more or less uniformly distributed. Legs very long .... *A. crenatum*

5. Coxae II–III with single, broad, ridge-like spur. Coxa IV with single, stout spur nearly twice as long as broad. Coxa I with two spurs; external much longer than internal. Eyes small and flat. Punctations unequal, numerous and uniformly distributed .... *A. testudinarium*

Coxae II–III with spine-like spur as long as broad or not much longer than broad 6

6. Coxa I with two short, blunt, nearly equal spurs. Pseudo-scutum well defined. Scutum nearly circular. Eyes very small. Spiracle large and sub-rectangular .... *A. malayanum*

Coxa I with two spurs; external longer than internal. Scutum broad-oval, narrowed anteriorly. Eyes large, conspicuous. Spiracle much longer than wide and comma-shaped 7

7. Coxa I with two spurs; external slightly longer than internal and not much longer than broad. Pseudoscutum scarcely indicated. Basis with numerous punctations. Punctations on scutum small to medium .... *A. cyprium cyprium*

Coxa I with two long spurs; external longer than internal and much longer than broad. Pseudoscutum acutely triangular. Basis lacks punctations. Punctations on scutum large. *A. babirussae*

Females

1. Coxa II with two spurs 2
   Coxa II with one spur 3
2. Coxa III with one spur. Scutum ornate. Punctations numerous, unequal and slightly confluent. Enamel markings on distal end of trochanter, femur, tibia and protarsus of leg I. Hypostome with 4 : 4 dentition .... *A. robinsoni*
   Coxa III with two spurs. Internal spur very small and scarcely visible. Scutum inornate and brown in color. Punctations unequal and more restricted to anterior half of scutum. Hypostome with 4 : 4 dentition .... *A. cordiferum*
3. Coxae II–III with ridge-like spur much broader than long 4
   Coxae II–III with spine-like spur as long as broad or not much broader than long 6
4. Medium-sized tick. Scutum inornate. Punctations numerous, small to medium and shallow. Eyes often indistinct. Hypostome with 3 : 3 dentition .... *A. javanense*
   Large-sized tick. Scutum ornate. Eyes large, pale and flat 5
5. Hypostome with 3 : 3 dentition anteriorly and 4 : 4 posteriorly. Scutum triangular with pointed scapulae. Eyes bulging beyond scutum. Postero-internal angle of festoons salient making posterior margin serrate. Legs unusually long. *A. crenatum*
   Hypostome with 4 : 4 dentition throughout length. Scutum cordiform with scapulae less pointed. Eyes large, flat and not bulging. Posterior body margin not serrate. *A. testudinarium*
6. Hypostome with 3 : 3 dentition. Scutum ornate. Punctations fine to medium, uniformly distributed. Eyes small, pale and often indistinct. Coxa I with two spurs; external nearly three times as long as internal .... *A. helvolum*
   Hypostome with 4 : 4 dentition 7
7. Dorsal foveae unusually large, appearing as two adjacent, salient plaques posterior to scutum. Scutum with posterior

angle very broad. Punctations numerous, deep, slightly unequal, partially confluent and uniformly distributed. *A. malayanum*

Dorsal foveae small, inconspicuous or absent 8

8. Scutum ornate and triangular, with sides nearly straight. Porose areas large, oval, closely set and divergent anteriorly. Coxa I with two short, flat spurs as wide as long .... *A. geoemydae*

Porose areas small and widely separated 9

9. Coxa I with two short, blunt, subequal spurs; external slightly longer than internal. Scutum triangular-cordiform, broader than long and with extensive ornamentation. Punctations small to medium. Legs with pale mother-of-pearl marking at distal end of each joint .... *A. cyprium cyprium*

Coxa I with long, pointed, external spur nearly three times as long as short, blunt internal spur. Scutum triangular, with reduced ornamentation. Large, deep punctations in lateral fields. Legs pale-green, with enamel markings on some segments .... *A. babirussae*

Amblyomma babirussae Schulze.

Amblyomma babirussae Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pts. 2–3, p. 525 [*nomen nudum;* morphological]; 1933, Zool. Anz., **104,** pts. 11–12, pp. 317–320, figs. 1–5 (3 ♂, 7 ♀, 2 n, Boeroe Island or Celebes, off "*Sus babirussa*" = *Babirussa babyrussa;* 3 n, Minahassa, Celebes; type in Zool. Mus. Greifswald, Germany) [validates *nomen nudum* of 1932]; 1936, Zeitschr. Morph. Oekol. Tiere, **31,** pt. 3, pp. 431–432, figs. 1–2 (morphological); 1941, *Op. cit.,* **37,** pt. 3, pp. 514, 515, 517 (morphological); 1943, *Op. cit.,* **39,** pt. 2, p. 324, fig. 3 (n, Celebes).

Amblyomma cyprium Krijgsman and Ponto, 1931, [*nec* Neumann, 1899] Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 143, map 4; 1932, [*nec* Neumann, 1899] Veeartsenijk. Meded., No. **79,** pp. 21–22, figs. 25–26 (♂, ♀, Celebes, off *Sus celebensis,* cow, buffalo). Toumanoff, 1944, [in part: *nec* Neumann, 1899], Les Tiques (Ixodoidea) de l'Indochine, pp. 106–111, Pl. 78, figs. *c–d* [only the male, after Krijgsman and Ponto; *nec* female].

In 1932 Krijgsman and Ponto erroneously described and illustrated the male and the female of *babirussae* as those of *cyprium.* Toumanoff in 1944 has taken the description and figure of the male from Krijgsman and Ponto; his female is another species, probably *A. malayanum.*

Male (Fig. 17A–F). Two specimens respectively 3.2 and 3.0 mm. long by 2.8 and 2.8 mm. wide, exclusive of capitulum. Scutum nearly circular, but narrowed in region of eyes, brown-black, with ornamentation apparently limited to posterior angle of triangular pseudoscutum; punctations large, very coarse, deep and partially confluent; all raised surfaces without punctations; cervical grooves deep and short; eyes dark and not very conspicuous; festoons distinct and punctate; no marginal groove. Body ventrally wrinkled, lighter and with short, white hairs; genital opening opposite coxa II; anal opening opposite spiracle; spiracles comma-shaped. Legs long, slender and pale green; tarsus I with hump, tapering abruptly; tarsus IV tapering gradually, with two ventral spurs; claws about twice as long as pulvillus; coxa I with two unequal, separated spurs, external long, narrow and pointed, internal short and blunt; coxae II–III with a single, moderately long, external, pointed spur; coxa IV with a single, long, pointed spur mesially placed. Capitulum 0.8 mm. long; basis rectangular; cornua slight; palpal articles relatively short, rugose and hirsute; article two about twice as long as article three; hypostome short; dentition 4: 4, with six to eight teeth per file.

Female. (Fig. 17G–L). Engorged specimen 7.2 mm. long by 6.0 mm. wide, exclusive of capitulum; partially engorged specimen 4.05 mm. long by 2.7 mm. wide, exclusive of capitulum. Scutum respectively 1.5 and 1.62 mm. long by 1.8 and 1.95 mm. wide, triangular, lateral margin nearly straight, and posterior angle not very broad, light-brown to reddish-brown, with metallic orange and greenish-yellow markings; punctations large, coarse, deep and restricted mainly to lateral regions, but smaller ones in scapular and median areas; cervical grooves short and deep anteriorly, continuing posteriorly as wide, shallow grooves, but not reaching posterior margin of scutum; no hairs on scutum. Abdomen reddish-brown, finely striate, with numerous, large punctations from each of which arises a long, stout, white, appressed hair; postero-median and two postero-lateral grooves present; marginal groove absent; festoons longer than wide, and grooves separating them narrow and deep. Ventral body surface with short, white hairs on posterior half; genital opening opposite coxa II; anal opening opposite spiracular plate; spiracular plate triangular, with rounded sides; genital grooves diverging widely at level of anal opening; anal groove

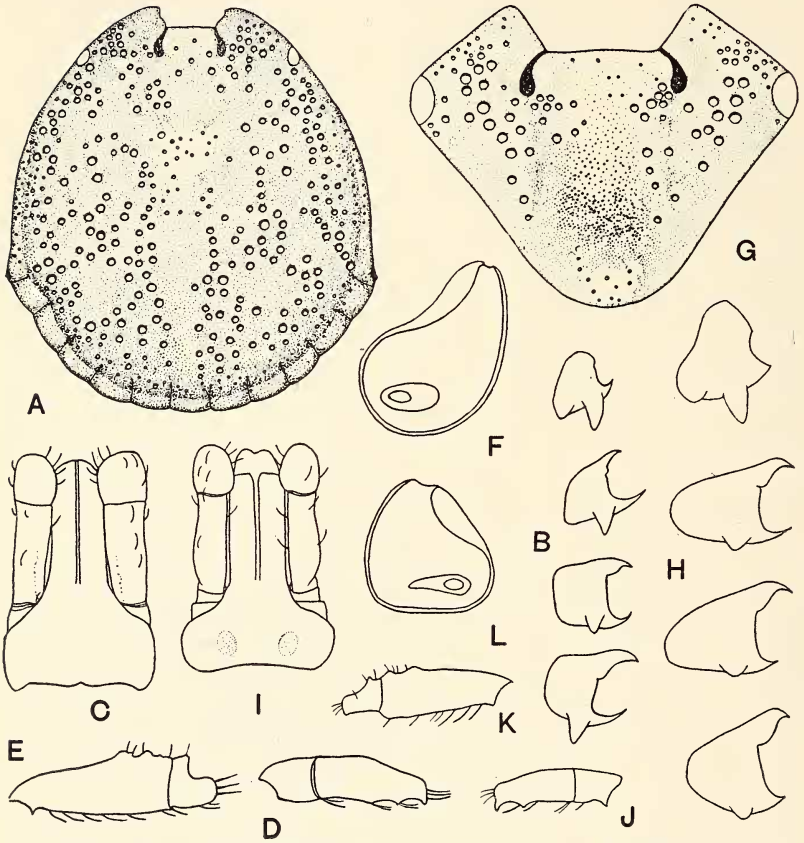

Fig. 17. *Amblyomma babirussae* Schulze. A–F, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, tarsus IV; E, tarsus I; F, spiracle. G–L, female: G, scutum; H, coxae I–IV; I, capitulum in dorsal view; J, tarsus IV; K, tarsus I; L, spiracle.

semi-circular, not touching genital groove. Legs long and fairly slender; tarsus I with three dorsal humps, tapering abruptly from third hump, and not terminating in a ventral spur; tarsi II–IV without humps, tapering gradually, but with a terminal and a subterminal spur; pulvillus about one-half as long as claws; coxa I with a long, pointed, external spur and a short, blunt, internal spur; coxae II–IV with a single, short, blunt spur wider than long. Capitulum 1.15 mm. long; palpal article two slightly over twice as long as article three; palps with long, white hairs; basis very broad, with lateral margins rounded and with posterior margin slightly concave; cornua very short, blunt, and insignificant; porose areas small, oval and widely separated; hypostome dentition 4 : 4, with approximately ten large teeth per file.

Distribution and hosts. This species appears to be restricted to Celebes. Specimens were seen from the following localities in Celebes: Makale, two females, off horse and buffalo, in Kraneveld collection; Lindoe Lake, Central Celebes, one female, off man, in Museum of Comparative Zoölogy; and Manado, fifteen males, six females, eighteen nymphs and one larva, off deer and wild pig, in de Boer collection.

Biology. Schulze referred to this species several nymphs unusual in that the scutum is ornate. The nymphs seen in the de Boer collection are also ornate.

Amblyomma cordiferum Neumann.

> *Amblyomma cordiferum* Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 204, 218–219 (1 ♀, Banda Island; doubtfully 6 n, Ternate; type in Hamburg M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 474. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 128. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 58, 67, 84. Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 25, 188–190, fig. 90 (description and figure from type). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, Map 4; 1932, Veeartsenijk. Meded., No. **79,** pp. 23, 35, fig. 33, Map 4 (♀, Krakatau Island, off python). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 117, 120.

Since no specimen was seen from the East Indies, a female from Siam was used for the following description.

Female (Fig. 18A–F). Partially engorged specimen 8.22 mm. long by 6.18 mm. wide, exclusive of capitulum. Body nearly rectangular, with sides sub-rectilinear. Scutum inornate, cordiform, broader than long, 3.0 mm. long by 3.78 mm. wide, sides rounded, with posterior angle broad; outlined by a narrow, dark brown border extending around eyes; punctations large, shallow, and only in anterior half of scutum; cervical grooves anteriorly short and deep, prolonged posteriorly as shallow depressions; eyes large and outlined by small punctations. Abdomen with numerous, large, sparsely scattered punctations and with very short, white hairs; dorsal foveae conspicuous; median groove extending from middle festoon anteriorly two-thirds distance to scutum; oblique grooves from second and third festoons, interrupted along their length, but continuing almost to scutum; three lateral depressions on each side; no marginal groove; festoons prominent and about as long as wide; abdomen ventrally lighter, with large punctations on lower third and with large, white hairs; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate; groove behind anal opening distinct and deep; brown, triangular, spiracular plates, with rounded angles and a dorsal prolongation. Coxae

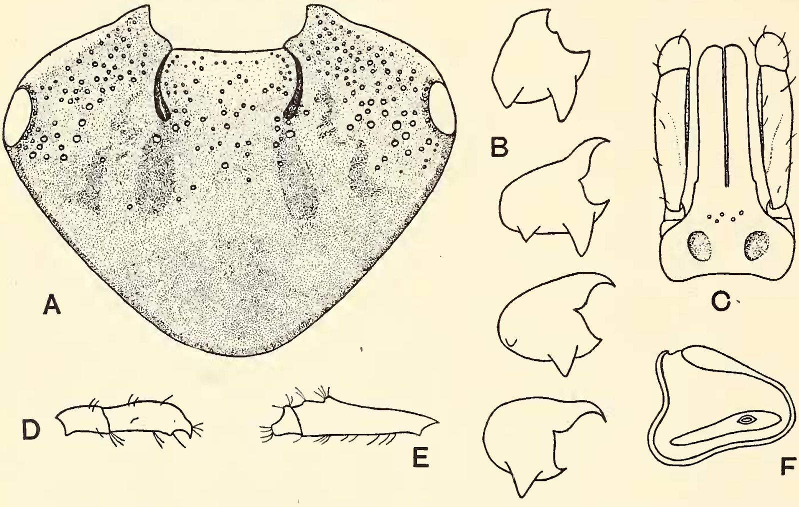

Fig. 18. *Amblyomma cordiferum* Neumann. Female: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, tarsus IV; E, tarsus I; F, spiracle.

small and finely punctate; coxa I with two unequal, conical, pointed and widely separated spurs; coxae II and III with two spurs; internal spur on coxa II distinct, but on coxa III very small, scarcely visible; coxae II–IV with external spur triangular, well developed and nearly equal; legs light and medium; femur, tibia and protarsus with pale markings on dorsal, distal portion; tarsi II–IV tapering gradually and ventrally with a distinct, terminal and subterminal spur; pulvillus about two-thirds length of claws. Basis rectangular and about twice as wide as long, with posterior margin slightly concave, and posterior angles slightly salient; porose areas fairly large, far apart, elliptical, and divergent anteriorly; few, small punctations anterior to porose areas; palps fairly long and slender; article two slightly over twice as long as article three; hypostome long and narrow, with 4 : 4 dentition.

Distribution and Hosts. Known from Banda Island (Neumann, 1899) and Krakatau Island (Krijgsman and Ponto, 1932). In the Museum of Comparative Zoölogy was seen one female collected by C. J. Aagaard at Bangkok, Siam, off *Ophiophagus hannah.*

Amblyomma crenatum Neumann.

Amblyomma crenatum Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 203, 214–215, fig. 52 (1 ♀, Cape of Good Hope, off *Rhinoceros*; type in Paris M.); 1901, *Op. cit.,* 14, pp. 297–298 (2 ♂, 2 ♀, Sumatra?). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 473. Howard, 1908, Ann. Transvaal Mus., **1,** pt. 2, p. 145, Pl. 12, fig. i. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 128. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 54, 57, 62, 66, 77–78, fig. 34 (♂, ♀, Cape of Good Hope, Liberia, Sumatra (?), off *Rhinoceros bicornis*); 1913, Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale (1911–1912), Résultats Scientifiques, Arachnides, 2, Ixodidae, p. 29 (1 ♀, Mbuyuni, Pori de Sérenghéti, Kenya Colony). Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 12, 21, 75–79, figs. 32–33 (1 ♂, from Imp. Bur. Ent.). Bequaert, 1933, Psyche, **40,** 4, pp. 137–140 (24 ♂, 12 ♀, Sungei Lampan, Lower Perak, Federated Malay States, off *Rhinoceros sondaicus*).

Amblyomma subluteum Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 201, 263 (2 ♂, one locality unknown, one off African rhinoceros; cotypes in Paris M.); 1901, *Op. cit.*, **14**, p. 309. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 472.

There is still uncertainty as to the exact range of *A. crenatum*. It has been recorded from Africa and from the Indo-Malayan region. In 1899 Neumann described the species from a single female from the Cape of Good Hope, South Africa. In the same year he also described *A. subluteum* from two males; the locality of one was unknown, and the other was from Africa. In 1901 Neumann saw in the Berlin Museum two dried males and two dried females collected in Sumatra by Mösch. On the basis of these four specimens he associated the males and females in his collection as one species, and he regarded *A. subluteum* as a synonym of *A. crenatum.* Neumann was doubtful that a species could be so widely separated, and he attempted to explain this unusual distribution by regarding the specimens from Sumatra as having been incorrectly labeled. In 1911 he added Liberia without indication of specimens. In 1913 Neumann recorded another female specimen from Mbuyuni (Pori de Sérenghéti), Kenya Colony, East Africa. This specimen was taken March 13, 1912, without indication of host. Robinson in 1926 also regarded *A. crenatum* as an African species and thought that the Sumatran material was incorrectly labeled. Bequaert in 1933 determined this species in Lower Perak, Federated Malay States. A portion of the twenty-four males and twelve females of this lot is in the Museum of Comparative Zoölogy, as well as two males collected in Java by Palmer and Bryant in 1910, with no indication of host. Bequaert, who had not seen Neumann's 1913 paper, regarded the African records as doubtful; he thought that they might have been taken off animals kept in captivity in Europe. It would be a simple matter to so disregard Neumann's two records from Africa, since they are vague as to the specific locality; however, the record of the one female from Mbuyuni is complete in this respect. The occurrence of this species in the Indo-Malayan region is now positively established, and the possibility that this species is also found in Africa can not be overlooked. Before final judgement can be made as to the complete range of this species, it is necessary that this one African specimen recorded by Neumann be re-examined. If it is not *A. crenatum* then Bequaert may be correct in assuming that the Indo-Malayan region is the only true origin of this species.

Male (Fig. 19A–F). Two Java specimens and fourteen Malayan specimens show a comparatively wide range of variation in

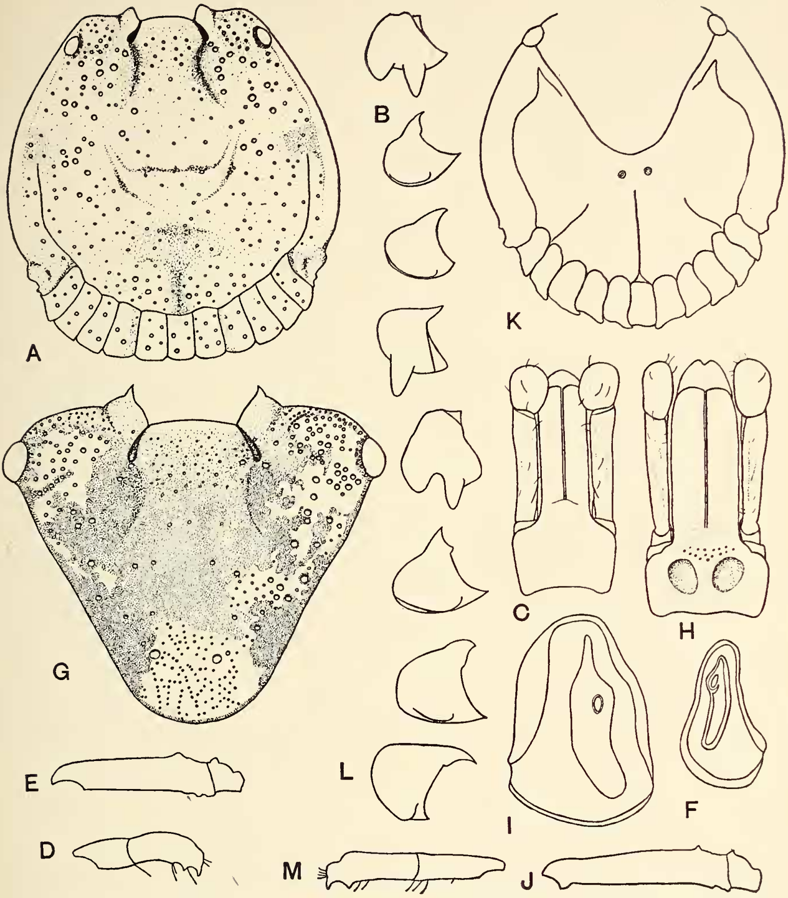

Fig. 19. *Amblyomma crenatum* Neumann. A–F, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, tarsus IV; E, tarsus I; F, spiracle. G–M, female: G, scutum; H, capitulum in dorsal view; I, spiracle; J, tarsus I; K, body in dorsal view; L, coxae I–IV; M, tarsus IV.

size, from 8.1 to 5.1 mm. long by 8.1 to 5.2 mm. wide, exclusive of capitulum; average 6.98 mm. long by 7.05 mm. wide. Scutum almost orbicular, narrowed slightly behind region of spiracular plate, yellow-orange and with a few, scattered, dark-brown markings, a pale, metallic marking in region of each cervical groove and in area anterior to each eye; punctations large to small; larger ones slightly confluent in posterior portion; cervical grooves short, deep and well defined; yellow, flat eyes very far anteriorly; marginal groove extending only a short distance anteriorly from festoons; spiracular plate large and triangular; festoons very long, with graceful curves on inner margins. Legs very long, yellow-orange, with occasional dark bandings; tarsus I long, slender and with two dorsal humps; tarsus IV ventrally with a terminal and sub-terminal spur; coxa I with two spurs, external pointed and about twice as long as internal; coxae II and III with a broad and ridge-like spur; coxa IV with a single, moderately long spur, about twice as long as wide. Capitulum 3.0 mm. long; basis rectangular, slightly narrower in posterior portion; palps very long and slender; article two about three times as long as article three; hypostome dentition 3 : 3, with seven to eight teeth per file.

Female (Fig. 19G–M). Four unengorged Malayan specimens from 9.4 to 9.1 mm. long by 9.4 to 8.8 mm. wide, exclusive of capitulum; average 9.3 mm. long by 8.9 mm. wide; two fully engorged females respectively from 22 to 23 mm. long by 20 mm. wide by 16 to 17 mm. thick. Scutum triangular, 4.1 mm. long by 4.7 mm. wide; ornamentation variable, but with a spot in each corner; larger punctations slightly confluent and restricted to antero-lateral regions; finer punctations more numerous and more uniformly distributed; cervical grooves short and deep, continuing posteriorly as shallow furrows toward postero-lateral margin; eyes large, flat and yellow, extending beyond lateral margins of scutum. Marginal groove distinct; festoons large and longer at postero-internal angle, making posterior margin of abdomen saw-toothed; abdomen ventrally with numerous, short, white hairs and many punctations; spiracular plates large, triangular and with rounded corners. Legs very long; tarsus I long and slender, with two dorsal humps; tarsus IV ventrally with a terminal and sub-terminal spur; coxa I with two spurs, internal more blunt than that of male; coxae II and III with a broad and ridge-like spur; coxa IV with a single spur, much shorter than that of male. Capitulum 3.3 mm. long; basis nearly rectangular and broader in front; porose areas large, depressed and divergent; palps very long and slender; notched hypostome with 3:3 dentition anteriorly, becoming 4:4 in posterior third.

Distribution and Hosts. It has been recorded from Africa (Neumann, 1899, 1911, 1913) and from the Federated Malay States (Bequaert, 1933). Six females and fourteen males were seen in the Museum of Comparative Zoölogy from Lower Perak, Federated Malay States, taken off *Rhinoceros sondaicus.* These are part of the same lot referred to by Bequaert in 1933. Two male specimens seen in the Museum of Comparative Zoölogy were collected by Palmer and Bryant in 1910 at Tamandjaija, Bantam, Java, without indication of host.

Biology. Amblyomma crenatum shows a remarkable adaptation to its peculiar host, the rhinoceros. The capitulum is very long, and it is capable of penetrating the thick skin easily; the large articles of the cheliceral digits are well adapted for cutting through the tough hide of this animal; and the very long legs enable the tick to move easily over the large body of its host. The two devices which aid most ticks in the process of attaching to their hosts are the claws and spurs. In this case the claws are very long and are about two and a half times as long as the pulvillus. The ventral terminal and sub-terminal spurs of the tarsus are also large. When the tick is about to attach, the claws hold the tick temporarily in place; the legs are then flexed, and this action pulls the spurs firmly into the hide anchoring the tick securely until the hypostome can be inserted. After it is inserted, the hypostome acts as the main organ of attachment. The sharpness of the spurs can be readily demonstrated when a leg is pulled across the finger, for the spur will easily penetrate the skin.

Amblyomma cyprium Neumann.

This species was divided into two subspecies by P. Schulze in 1933. The typical form has a wider distribution, whereas the subspecies, *A. cyprium aeratipes* Schulze, appears to be restricted to the Philippine Islands.

Amblyomma cyprium cyprium Neumann.

Amblyomma cyprium Neumann, 1899, Mém. Soc. Zool. France, **12**, pp. 202, 204, 219–221 [in part; not one male from Philippine Islands] (3 ♂, 5 ♀, Mariana Is.; 1 ♀ without locality; cotypes at Paris M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 473, 474. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 128. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 56, 59, 64, 67, 87–88 [in part: not the Philippine record] (New Guinea, Malay Peninsula, off Chelonia). Jepson, 1911, Council Paper No. **25,** Dept. Agric., Fiji, p. 32 (Fiji Is., off bush pig and cattle). Patton and Cragg, 1913, Textbook Medical Ent., p. 616. Turbet, 1924, Ann. Rept. Vet. Officer, Dept. Agric., Fiji (off horses, pigs and cattle in Fiji Islands.) Fielding, 1926, Comm. Austral. Service Publ. (Trop. Div.) No. **9,** pp. 82–83. Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 17, 21, 233–236, fig. 115 [in part: description and figure of ♂, *nec* ♀] (♂, Celebes, off *Sus celebensis*). Schulze, 1936, Meddel. Zool. Mus., Oslo, No. **45,** p. 158 (morphological); 1941, Zeitschr. Morph. Oekol. Tiere, **37,** pt. 3, pp. 514, 517 (morphological). Lever, 1943, Agric. Journ., Fiji, **14,** pt. 2, p. 40 (♀, Nadarivatu, Fiji, off man). Alicata, 1948, Pacific Science, **2,** pt. 1, p. 65 (Guam).

Amblyomma scaevola Oudemans, 1905, Ent. Ber. Nederl. Ent. Ver., **1,** pt. 22, p. 216 (♂, Manokwari, New Guinea; type in Zool. M. Amsterdam); 1906, Nova Guinea, **5,** Zool., pt. 1, pp. 105, 130–131, Pl. 3, figs. 51–58. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 56, 64, 87. Fielding, 1926, Comm. Australia Service Publ. (Trop. Div.), No. **9,** pp. 83–84.

Amblyomma quasicyprium Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 21, 237–238, fig. 117 (1 ♀, Frontera, Tabasco, Mexico, off *Ateles melanochir;* 1 ♀, Tavenni, Fiji Is., off cow; cotypes in Brit. Mus.). Schulze, 1933, Zool. Anz., **104,** pts. 11–12, p. 322 (true female of *A. cyprium;* Mexico is incorrect locality).

Amblyomma dammermani Warburton, 1927, Parasitology, **19,** pt. 4, pp. 409–410, Pl. 27, fig. 3 (1 ♀, Goenoeng Daab, Great Kei Id., without host; type in Zool. M. Buitenzorg). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, map 4; 1932, Veeartsenijk. Meded., No. **79,** pp. 23, 35, fig. 37, map 4. Schulze, 1936, Meddel. Zool. Mus., Oslo, No. **45,** p. 158 (morphological). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 116, 120, Pl. 82.

In 1932 Krijgsman and Ponto recorded males of this species from Celebes, but their figure of the female is that of another species, *A. babirussae* Schulze. Toumanoff recorded this species from Central Annam in 1944, but his figures *a-b*, plate 78, represent the female of another species closely resembling *A. malayanum* Neumann. Warburton described *A. dammermani* in 1927 from one female collected in the Kei Islands by H. C. Sibers, and he illustrated his description with a dorsal view photograph. In 1932 Krijgsman and Ponto, who also saw this same specimen in the Buitenzorg Museum, made an accurate drawing of it. Since these descriptions and illustrations agree in every respect with females of *A. cyprium* I have from the Flores Islands, Fiji Islands and New Hebrides, I regard *A. dammermani* as a synonym of *A. cyprium cyprium*.

The great confusion present in this species is due to Neumann's failure to illustrate it and to give an adequate description. As a result, females of several closely related species have been confused. I found enough males and females in association to convince me of their relationship.

In 1933 Schulze described the subspecies *A. cyprium aeratipes* from the Philippine Islands. I saw numerous specimens from the same islands, and I agree that they are distinct from the typical form. The males of the two subspecies resemble each other closely, but the females are readily distinguished. All of the earlier records from the Philippine region are included under the synonymy of the subspecies *aeratipes* Schulze. I believe that there is justification for this, for I have seen very many specimens from these islands, and in no case did I see any which could be ascribed to the typical form.

Male (Fig. 20A–F). Two unengorged specimens from Roeteng, Flores, respectively 5.85 and 5.8 mm. long by 5.4 and 5.1 mm. wide, exclusive of capitulum. Body broad-oval, narrowed anteriorly in front of eyes and widest in front of posterior third. Scutum slightly convex, reddish-brown, with some copper-colored markings anterior to eyes or on pseudo-scutum; pseudo-scutum very pronounced; punctations large, numerous and deep at periphery, but almost completely lacking in semi-lateral and median regions; partially confluent in region of lateral margins; cervical grooves short, deep and prolonged posteriorly as shallow depressions; eyes large, flat and yellow-orange; no lateral groove; festoons longer than wide. Ventral, abdominal surface yellow, finely punctate and finely wrinkled; numerous, small, white hairs posteriorly; genital opening opposite coxa II; spiracles large and comma-shaped; anal opening opposite posterior border of spiracle. Legs long, stout and reddish-brown, with many, long, white hairs; coxa I with two short, flat spurs; external spur longer than internal spur; other coxae with a single, strong, triangular spur; tarsi long, tapering gradually; tarsi of second, third and fourth pair of legs ending in a strong, terminal and sub-terminal spur; claws about twice the length of small pulvillus. Capitulum comparatively short; rectangular basis slightly broader than long, with short cornua; posterior portion of basis with many punctations, some slightly confluent; short palps wrinkled and with numerous, long, white hairs; second article about twice the length of third article; hypostome

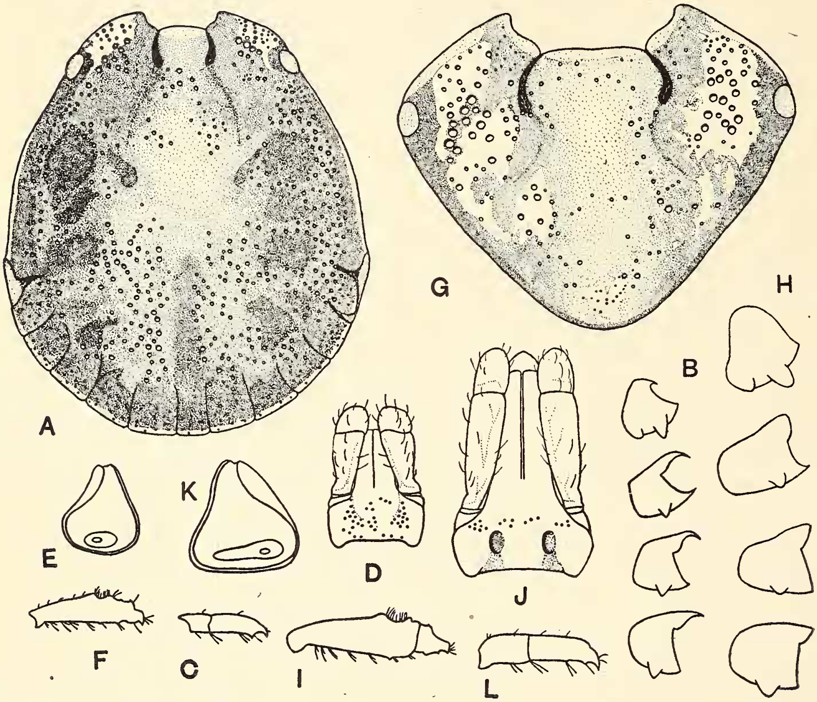

Fig. 20. *Amblyomma cyprium cyprium* Neumann. A–F, male; A, scutum; B, coxae I–IV; C, tarsus IV; D, capitulum in dorsal view; E, spiracle; F, tarsus I. G–L, female: G, scutum; H, coxae I–IV; I, tarsus I; J, capitulum in dorsal view; K, spiracle; L, tarsus IV.

shorter than palps; dentition 4:4, with inner row shorter than others.

Female (Fig. 20G–L). One partially engorged specimen from Roeteng, Flores, 10.02 mm. long by 8.4 mm. wide, exclusive of capitulum. Scutum from 3.3 to 3.12 mm. long by 3.9 to 3.6 mm. wide in five specimens; average 3.19 mm. long by 3.7 mm. wide; triangular-cordiform, wider than long, posterior angle broad, reddish-yellow with a complete, dark brown border extending posteriorly from eyes; pattern of enamel markings variable; large spots in antero-lateral regions and a small spot in posterior angle; markings in median area present or absent; punctations in antero-lateral areas larger and more numerous; those in remainder of scutum smaller and more sparsely distributed; cervical grooves deep and wide anteriorly; large, conspicuous, yellow eyes set off by dark eye spots. Abdomen yellow-brown, finely wrinkled and with very numerous punctations; a short, white hair in each punctation; festoons as broad as long; no marginal grooves; abdomen ventrally with hairs less numerous and much smaller; genital opening small and opposite coxa II; anal opening opposite spiracle; triangular spiracle with rounded corners. Brown legs with pale mother-of-pearl markings at distal end of each joint; long, white hairs on all legs; coxa I with two short, sub-equal spurs, external slightly longer than internal spur; other coxae with a single, broad, short spur; tarsus IV small, cylindrical, tapering gradually and with a terminal and sub-terminal spur; pulvilli medium-sized. Capitulum slightly over 2 mm. long, rectangular and broader than long, with sides slightly convex; cornua short and blunt; porose areas small, deep and widely separated; hypostome long and straight, with 4:4 dentition; palps long; article two slightly over twice as long as article three; palps slightly longer than hypostome.

Distribution and Hosts. This subspecies is widely distributed and is known from the Mariana Islands, New Guinea, Malay Peninsula, and the Fiji Islands. In the East Indies it is known from Celebes (Robinson, 1926) and Kai Island (Warburton, 1927; Krijgsman and Ponto, 1931, 1932). Specimens were seen from the following localities in the Oriental Region: Flores (Roeteng, five females and two males, off buffalo, in Kraneveld collection), Mariana Islands (Ladrones Islands, one female, in Museum of Comparative Zoölogy), Fiji Islands (Nagaranabuluti, near Nadarwatu, one female, off man, R. A. Lever coll., in Rocky Mountain Laboratory; Suva, one male, W. M. Mann coll.; Veti levu, Saiaro, one male, W. M. Mann coll.; Fiji, six females, W. M. Mann coll., all in Museum of Comparative Zoölogy), New Hebrides (Espiritu Santo, one female, one male, G. Banner coll., in Rocky Mountain Laboratory; Erromango, one male, one female; Tanna Island, one male, all in Museum of Comparative Zoölogy), New Guinea (Bululo, one male, four females, off *Sus papuensis*, C. Gunther coll.; Biak or Owi Island, one female, off man, R. S. Fitz coll.; Finschafen, one male, E. S. Ross coll.; Sansapor, one male, on clothing of man, G. M. Kohls coll.; all in Rocky Mountain Laboratory), Santa Cruz Group (Vanikoro Island, one female, off wild pig, E. Troughton and A. Livingstone coll., in Rocky Mountain Laboratory).

Biology. The original host of this tick was unknown. In 1911 Neumann gave turtles as such, but without stating on what evidence. Krijgsman and Ponto in 1932 list the same host, apparently repeating Neumann. I doubt that this tick occurs on reptiles, for a study of the many host records shows that only mammals are attacked. There are no definite or authentic records of its ever having been taken off reptiles.

Amblyomma cyprium aeratipes Schulze.

Amblyomma cyprium aeratipes Schulze, 1932, Zeitschr. Morph. Oekol., Tiere, **25**, pts. 2–3, p. 526 [*nomen nudum;* morphological]; 1933, Zool. Anz., **104**, pts. 11–12, pp. 321–322 (1 ♂, Momangan, North Mindanao; 1 ♀, Pt. Banga, Mindanao; type ♂ in Berlin Museum) [validates *nomen nudum* of 1932]; 1936, Meddel. Zool. Mus., Oslo, No. **45**, p. 158 (morphological).

Amblyomma cyprium Neumann, 1899, Mém. Soc. Zool. France, **12**, p. 221 [in part: only the male from Philippine Islands]; 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 88 [in part: only Philippine record].

Male. This subspecies is darker than the typical form. The greenish-enamel markings on the legs are very pronounced and give the legs a banded appearance at the joints. In the typical form the markings are more mother-of-pearl and do not show this characteristic banding. The pseudoscutum is markedly set off by ornamentation, but in the typical form ornamentation is usually found on the antero-lateral margins only. Specimens of *A. cyprium aeratipes* studied are uniformly, heavily punctate, and these punctations are confluent in the median and posterior regions. In the typical form the punctations are less numerous in the median area, and they are confluent only slightly in the posterior region.

Female. The Philippine subspecies is generally darker, and the posterior angle of the scutum is more pointed than that of the typical form. The punctations of *aeratipes* are larger, more numerous and slightly confluent. The greenish-enamel markings on the legs are very pronounced, while those of the typical form are mother-of-pearl. The spurs on coxa I are longer than those of the typical form; the external spur is about twice as long as the internal in contrast to the typical form where they are nearly equal.

Distribution and Hosts. Seventeen lots were seen agreeing with Schulze's description of *A. cyprium aeratipes.* These lots include twenty-seven females and eight males, and all are restricted to the Philippine Islands. Where host records are stated they are off man with the exception of one unusual record in the Rocky Mountain Laboratory of a female taken off a bird, *Harpactes ardena rhodiosternum* by H. Hoogstraal in Mindanao.

Amblyomma geoemydae (Cantor).

Ixodes geoemydae Cantor, 1847, Journ. Asiatic Soc. Bengal, **16,** pt. 2, p. 608 (♀, Pinang Hills, Sumatra, off *Geoemyda spinosa;* type in British Museum).

Amblyomma geoemydae Neumann, 1906, Arch. de Parasitol., **10,** pt. 2, pp. 214–216, figs. 15–16 (examined type; 3 ♀, Mt. Kinabalu, Borneo); 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 59, 68, 88. Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 21, 230–231, fig. 113. Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, map 4; 1932, Veeartsenijk. Meded., No. **79,** pp. 23, 35, fig. 34, map 4. Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 116, 120, Pl. 84.

Amblyomma geomydae Schulze, 1932, Zeitschr. f. Parasitenk., **4,** pt. 3, pp. 470–471, fig. 7 (1 ♀, n, Soekaranda, Sumatra); 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pt. 2–3, p. 525 (morphological).

Haemalastor geoemydae Oudemans, 1936, Krit. Histor. Overzicht Acarologie, **3,** Bd. B, pp. 487–488.

This species was not seen and the following description of the female, taken from Neumann, 1906, and from Robinson, 1926, gives the main diagnostic characters. Scutum triangular, with sides nearly straight and with posterior angle narrow; ornate, with three yellow spots on maroon-brown background; cervical grooves long, distinct and concave externally; punctations numerous, large, unequal and deep. Spiracular plate large and sub-triangular. Cornua absent; large, oval porose areas divergent anteriorly and close together; hypostome with 4:4 dentition. Coxa I with two flat, short, separated spurs as wide as long; coxae II–IV each with a single spur; tarsi long and terminating in talus; each ends in two small, consecutive spurs. The male is as yet unknown. The nymph, described and figured by Schulze (1932), is unusual in having pale enamel spots on the scutum.

Distribution and Hosts. The species is known thus far only from Sumatra and Borneo. It is probably restricted to land tortoises.

Amblyomma helvolum Koch.

Amblyomma helvolum C. L. Koch, 1844, Arch. f. Naturgesch., **10**, pt. 1, p. 230, No. 39 (♀, Manila; type in Berlin Museum); 1847, Uebersicht des Arachnidensystems, **4**, pp. 19, 93–94, Pl. 18, fig. 66. Neumann, 1899, Mém. Soc. Zool. France, **12**, pp. 278–279; 1901, *Op cit.*, **14**, p. 312 (corrects Neumann, 1899). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 130. Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 90 (uncertain species). Warburton, 1926, Treubia, **8**, pts. 3–4, p. 279 (4 ♀, Sinabang and Busung, Simeuloeë Island, Babi Island, off *Varanus salvator, Mabuya multifasciata, "Naja bungarus"* = *Ophiophagus hannah*). Robinson, 1926, Ticks, **2**, pt. 4, *Amblyomma*, pp. 16, 20, 216–219, fig. 106 (extensive host and distribution lists). Oudemans, 1928, Ent. Ber. Nederl. Ent. Ver., **7**, pt. 164, p. 376 (12 ♂, 2 ♀, Berhala Island, off *"Dipsadomorphus dendrophilus"* = *Boiga dendrophila;* 1 ♂, from pisang stem). Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 325–326 (2 ♀, Singora, Siam, off *Coluber radiatus;* 2 ♀, off *Varanus nebulosus*). Oudemans, 1929, Tijdschr. Ent., **72**, Suppl., p. 208 (the "Goudachtig gevlakte teek" Wurmb, 1781, Verh. Bataviaasch. Gen., **3**, p. 400; "op de groote adder," python (?), Java). Vitzthum, 1931, Résultats Scientif. Voyage Indes Orient. Néerland. Prince Léopold, **3**, pt. 5, pp. 28–29 (♀, Tandjoeng Keling, Sumatra). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 143, map 4 (♂, ♀, Java, off *Varanus salvator* and *Mabuya multifasciata*); 1932, Veeartsenijk. Meded., No. **79**, pp. 23, 34, 35, figs. 29–30 (♂, ♀, Java). Schulze, 1933, Arch. f. Hydrobiol., Suppl.-Bd. **12**, pp. 495–496, 497, 498, figs. 3–4 (figures from type; 1 ♀, Leyte, P. I.; 7 ♂, Komodo, off *Varanus komodoensis;* 1 ♂, Endeh, Flores, off *Varanus salvator*). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 115, 118, 120, Pls. 82, 84.

Amblyomma decoratum C. L. Koch, 1844, Arch. f. Naturgesch., **10,** pt. 1, pp. 230–231, No. 40 (♂, Philippine Is.; type in Berlin M.); 1847, Uebersicht des Arachnidensystems, **4,** pp. 19, 94–95, Pl. 18, fig. 67. Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 203, 245 (5 ♂, Philippine Is.); 1901, *Op. cit.,* **14,** p. 304. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 473. Neumann, 1910, Ann. Sci. Nat. Zool., **9,** pp. 175–176 (4 ♂, Manila, Luzon; 1 ♂, off *Varanus salvator,* locality unknown; 1 ♀, Padang, Sumatra, off *Varanus salvator*). Warburton, 1910, Parasitology, **3,** pt. 4, p. 396 (Zool. Gardens, Calcutta, off *Geoemyda grandis;* Nicobar Islands, off *Varanus salvator*). Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 56, 57, 64, 67, 87 (♂, ♀, Philippine Islands, Java, Sumatra, off *"Zamenis mucosus"* = *Ptyas mucosus, Varanus salvator, Python reticulatus*).

Amblyomma fimbriatum C. L. Koch, 1844, Arch. f. Naturgesch., **10,** pt. 1, p. 231, No. 42 (♂, Manila); 1847, Uebersicht des Arachnidensystems, **4,** pp. 20, 95, Pl. 18, fig. 68.

Amblyomma quadrimaculatum Neumann, 1899, Mém. Soc. Zool. France, **12,** pp. 202, 245–246 (1 ♂, Java, off *"Triglyphedon dendrophilum"* = *Boiga dendrophila;* type described from Oudemans Coll., now at Leiden M.); 1901, *Op. cit.,* **14,** p. 304 (4 ♂ and 2 mutilated ♀, Java, off *Python reticulatus*). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 473. Schulze, 1933, Arch. f. Hydrobiol., Suppl.-Bd. **12,** pp. 492, 495, 497, 498, figs. 5–6 (5 ♀, Ranau, Sumatra, off *Varanus salvator;* 2 ♂, Java off *"Varanus bivittatus"* = *Varanus salvator,* 1 ♀, Edi, Sumatra; 3 ♂, Java, off *"Dipsadomorphus dendrophilus"* = *Boiga dendrophila*); 1943, Zeitschr. Morph. Oekol. Tiere, **39,** pt. 2, p. 355, fig. 38 (Sumatra; morphological). Buitendijk, 1945, Zoolog. Meded. Leiden, **24,** pts. 3–4, p. 285 (type; locality here given as Pulau Berhala).

Amblyomma furcosum Neumann, 1901, Mém. Soc. Zool. France,

14, pp. 299–300 (2 ♀, Java, off *Python reticulatus;* type in Berlin M.).

Amblyomma (*Aponomma*) *tenimberense* S. and L. Hirst, 1910, Ann. Mag. Nat. Hist., (8), **6**, pp. 307–308, fig. 9 (♂, Tanimbar Island, off *Varanus indicus;* type in Brit. Mus.).

Amblyomma feuerborni Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, **25**, pts. 2–3, p. 527 [*nomen nudum*] ; 1933, Arch. f. Hydrobiol., Suppl.-Bd. **12**, pp. 492–495, 497, 498, figs. 7–9 (4 ♂, 1 ♀, Klakah, Java, off snake, probably *Ptyas mucosus;* 1 ♂, same locality, off *Python reticulatus;* 3 ♂, Berhala Island, off *"Dipsadomorphus dendrophilus"* = *Boiga dendrophila* and undersized male from hollow pisang stem; holotype ♂ from Java, off ?*Ptyas*, in Z. M. Berlin) [validates *nomen nudum* of 1932].

Haemalastor helvolum Oudemanns, 1936, Krit. Histor. Overzicht Acarologie, **3**, Bd. B, pp. 492–494, figs. 199–200.

So many specific names are involved in the synonymy of this species that it is best to discuss them in chronological order.

In 1844 C. L. Koch described three species in the following sequence: *Amblyomma helvolum* based on a female from Manila, *Amblyomma decoratum* based on a male from the Philippine Islands, and *Amblyomma fimbriatum* based on a male from Manila. The types are in the Zoological Museum, Berlin. In 1847 he gave supplementary descriptions and figures for all three species. After examining five males collected by F. Semper in the Philippine Islands, Neumann decided in 1899 that they were *A. decoratum.* These specimens belonging to the Hamburg Museum had been named *"Ixodes aquilae,"* an unpublished name. In the same year he described *A. quadrimaculatum* from a male in the Oudemans' collection in Java. In 1899 he also published a short description of *A. helvolum* based upon the same female that Koch had described from Manila. In 1901 Neumann reduced *A. fimbriatum,* known from a single male specimen, to a synonym of *A. decoratum.* He also described *A. furcosum* in 1901 from two females collected in Java and deposited in the Berlin Museum, but in 1910, after seeing Koch's specimens, he reduced it to a synonym of *A. decoratum.* In the same year S. and L. Hirst described a new species, *Amblyomma* (*Aponomma*) *tenimberense,* from a male taken on Tanimbar Island. In 1911 Neumann reduced *A. quadrimaculatum* to a synonym of *A. decoratum.* Up to the time of Robinson in 1926, there were only three remaining names in this complex which were regarded as valid: *A. helvolum, A decoratum* and *A.* (*Aponomma*) *tenimberense*. Robinson compared the type of *A. helvolum* with numerous females of *A. decoratum;* because he could find no constant characters to distinguish them, he regarded *A. decoratum* as a synonym of *A. helvolum.* Robinson agreed with Neumann in degrading *A. fimbriatum, A. quadrimaculatum* and *A. furcosum* to synonyms of *A. decoratum.* Robinson also reduced *A.* (*Aponomma*) *tenimberense* to a synonym of *A. helvolum.* In 1933 Schulze claimed that three species had been confused in the *helvolum* group; he revived *A. quadrimaculatum,* and he described *Amblyomma feuerborni* from four males and one female from Java. The characters selected to separate these forms by Schulze are tenuous. I have compared specimens from the Philippine Islands, Java and Sumatra, and though slight differences exist in the males, they are probably due to individual variation. The females can not be separated. Only by rearing these forms in sufficient numbers could the question be settled definitely. For the time being I can only regard *A. feuerborni* and *A. quadrimaculatum* as synonyms of *A. helvolum.*

Male (Fig. 21A–F). Ten partially engorged specimens from 3.15 to 2.7 mm. long by 2.85 to 2.4 mm. wide, exclusive of capitulum; average 2.91 mm. long by 2.54 mm. wide. Body sub-quadrangular, posterior border slightly rounded, lateral margins slightly convex, reddish-brown; punctations unequal, numerous and evenly distributed in most specimens, but in some completely absent in median area; cervical grooves short, deep and slightly widened posteriorly; no elevations, depressions or lateral grooves; festoons distinct; eyes small, yellow and frequently indistinct; size, shape and distribution of markings variable; pale ornamentation generally distributed over body as a small marking in each scapular angle, an elongated marking in each lateral field and two adjacent, symmetrical spots in posterior region; some with median markings varying from one to three, but others lacking a median spot. Ventral body surface pale yellow and conspicuously wrinkled; numerous, short, white hairs on posterior third; genital opening opposite posterior border of coxa II; anal opening very far posteriorly and opposite posterior border of spiracular plate; anal groove very distinct; spiracular plates large and comma-shaped. Legs moderately long and stout; coxa I with two spurs, external about twice as long as internal; remaining coxae with a single, triangular spur; tarsi tapering gradually. Capitulum relatively long; basis rectangular

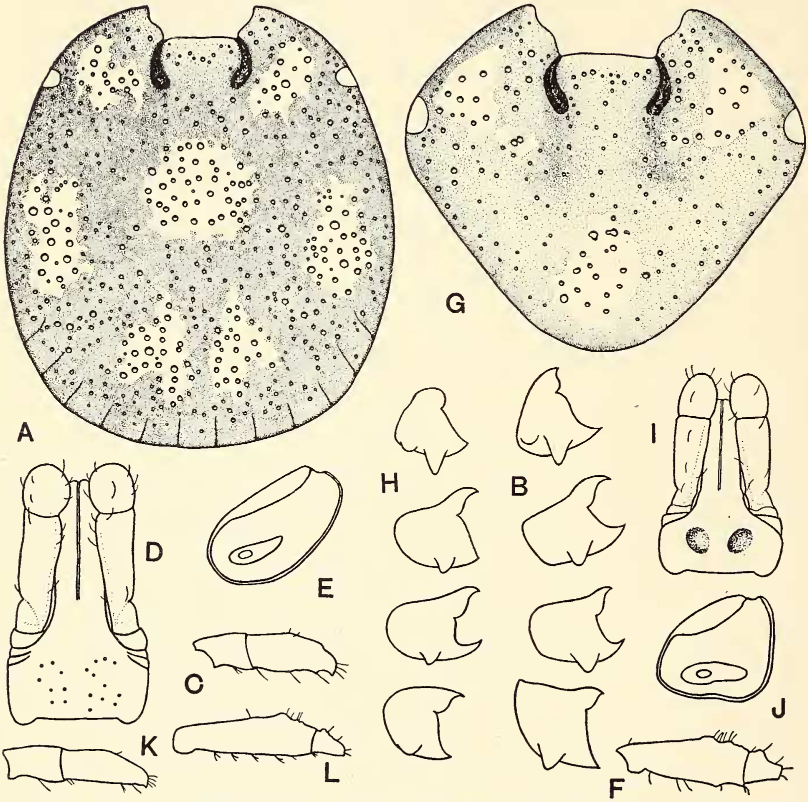

Fig. 21. *Amblyomma helvolum* Koch. A–F, male: A, scutum: B, coxae I–IV; C, tarsus IV; D, capitulum in dorsal view; E, spiracle; F, tarsus I. G–L, female: G, scutum; H, coxae I–IV; I, capitulum in dorsal view; J, spiracle; K, tarsus IV; L, tarsus I.

and slightly wider than long; palps long, with article two over twice as long as article three; hypostome long and spatulate; 3:3 dentition, with relatively large and distinct teeth.

Female (Fig. 21G–L). All partially engorged, and largest 5.4 mm. long by 4.05 mm. wide. Body broad-oval and narrowed anteriorly near scutum. Scutum from 2.1 to 1.8 mm. long by 2.4 to 2.22 mm. wide, average 1.94 mm. long by 2.27 mm. wide, small, sub-triangular, with rounded angles and posterior angle medium broad, postero-lateral margins sinuous to slightly convex, reddish-brown, ornate, with a large marking in each scapular angle and with one in posterior angle; size and shape of markings variable; punctations fine to medium and evenly distributed; cervical grooves short, deep and prolonged posteriorly as a very shallow depression; dorsal foveae well defined; eyes small, pale and often difficult to distinguish; festoons distinct and not widely separated. Ventral body surface similar in color to dorsal surface; numerous, fine punctations on posterior third, with short, white hairs; genital opening opposite coxa II; anal opening opposite posterior third of spiracular plate; spiracular plates broad. Legs moderately long and stout; external spur on coxa I much longer than very small internal spur; coxae II–IV with a single, medium-sized spur. Capitulum long; basis rectangular, broader than long, and with posterior angles slightly salient; porose areas large, deep and divergent; palps long; hypostome with 3:3 dentition.

Distribution and Hosts. This species is very widely distributed and is known from the Philippine Islands, Nicobar Islands, Netherlands East Indies, Federated Malay States, St. John's Island (Singapore), Borneo, New South Wales, India and Siam. In the East Indies it has been recorded from Java (Neumann, 1899, 1901, 1911; Robinson, 1926; Oudemans, 1929; Krijgsman and Ponto, 1931, 1932; Schulze, 1933), Sumatra (Neumann, 1910, 1911; Vitzthum, 1931; Schulze, 1933, 1943), Simeuloeë Island and Babi Island (Warburton, 1926), Berhala Island (Oudemans, 1928; Schulze, 1933), Komodo Island and Flores Island (Schulze, 1933), Tanimbar (S. and L. Hirst, 1910).

Numerous specimens from the Philippine Islands were seen in the Rocky Mountain Laboratory and in the Museum of Comparative Zoölogy. The following additional records from Java and Sumatra are based upon specimens seen in the Museum of Comparative Zoölogy: Java (Buitenzorg, fourteen males, one female, taken off snake by Palmer and Bryant, March 8, 1909; three females, three males, taken off *Varanus* sp. by Palmer and Bryant, March 28, 1909; two females, one male, collected by Palmer and Bryant, March, 1909. Depok, three males, one female, taken off cobra by Palmer and Bryant, July 7, 1909; one female taken off *Ptyas korros*). Sumatra (Dolok Merangir, E. coast of Sumatra, three females, taken off *Naja naja leucodira* by W. A. Bangham).

Biology. In 1926 Robinson reported finding one nymph with several males taken off "*Iguana*" = *Varanus* from St. John's Island (Singapore, Straits Settlement). Robinson neither figured nor described this nymph. In a lot of three males and three females, which had been taken off *Varanus* sp. by Palmer and Bryant in 1901 at Buitenzorg, Java, March 28, 1909, I found four nymphs which closely resemble the female of *A. helvolum*, and no eyes could be distinguished. These nymphs might possibly belong to the genus *Aponomma*, which lacks eyes, or it is possible that the immature forms of *A. helvolum* might lack eyes. This question can only be settled by breeding experiments.

Amblyomma javanense (Supino).

Rhipicephalus javanensis Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 233 (n, Karkecet (Tenasserim), off *Manis javanica;* type in Genoa M.). Neumann, 1897, Mém. Soc. Zool. France, **10**, p. 416.

Dermacentor indicus Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) **3**, pt. 1, p. 236 (♂, ♀, Kokarcet (Tenasserim); Bhamo, Burma, off *Manis javanica, "Manis aurita"* = *Manis pentadactyla dolmanni*); 1897, *Op. cit.*, (2) **3**, pt. 2, p. 251, Pl. 13, fig. 15. Neumann, 1897, Mém. Soc. Zool. France, **10**, pp. 382–383.

Aponomma politum Neumann, 1899, *Op. cit.*, **12**, p. 191 (2 ♂, off *Python molurus*, without locality; cotypes probably in Paris M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 470.

Amblyomma sublaeve Neumann, 1899, Mém. Soc. Zool. France, **12**, p. 204, 221 (2 ♀, Siam; cotypes in Paris M.); 1901, *Op. cit.*, 14, pp. 298–299 (2 ♂, 2 ♀, Canton, China). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 474. Warburton, 1910, Parasitology, **3**, pt. 4, p. 396 (many localities in India, off *Manis* spp. and "*Euprepes*" = *Mabuya*). Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 56, 59, 63, 64, 68, 85–86. Nuttall, 1914, Parasitology, **7**, pt. 3, p. 256, fig. 10 (n, Karkecet, Burma, off *Manis javanica;* in lot labeled *R. javanensis* by Supino). Warburton, 1925, Spolia Zeylanica, **13**, pt. 2, p. 256 (Colombo, Ceylon, off pangolin). Robinson, 1926, Ticks, **2**, pt. 4, *Amblyomma,* pp. 17, 23, 244–247, figs. 120–121 (♂, ♀, wide distribution and many hosts). Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 328–330, fig. 45 (♂, ♀, Central Prov., off *Manis* sp.; ♂, Bengal, off *Manis pentadactyla* and *"Nicoria tricarinata"* = *Geoemyda tricarinata;* ♀, Punjab, off *Vesperugo abramus;* ♂, Bombay Presidency, without host). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 143, map 4; 1932, Veeartsenijk. Meded., No. **79**, pp. 22–23, 34, 36, figs, 27–28, map 4 (♂, ♀, Java, off *Manis javanica*). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 104–105, 118, 120, Pls. 72–74 (♂, ♀, Cambodge and Cochin China, off bear, Sambar deer and wild pig).

Aponomma latum, Neumann [*nec* Koch, 1844] 1901, Mém. Soc. Zool. France, **14**, pp. 291–292, 344 (4 ♂, 1 ♀, India, off serpent) [in part: equals *Aponomma politum* Neumann, 1899, syn.]. Howard, 1908, Ann. Transvaal Mus., **1**, pt. 2, p. 153 (after Neumann, 1901). Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, p. 97 (uncertain species, Port Natal (Natal), India, off *Python molurus*) [in part: equals *Aponomma politum* Neumann, 1899, syn., *ex errore, fide* G. Theiler, 1945, The Onderstepoort Journ. Vet. Sci., **20**, pt. 2, p. 182].

Amblyomma badium Neumann, 1901, Mém. Soc. Zool. France, **14**, pp. 300–301 (3 ♂, Sumatra; 6 ♂, off *Manis* sp. without locality; 19 ♂, 6 ♀, 6 n, Java, off *Manis javanica;* cotypes in Z. M. Berlin and in Oudemans Coll. now in Leiden M.).

Aponomma javanense Cooper and Robinson, 1908, Proc. Cambridge Philos. Soc., **14**, pp. 464–466, figs. 15–17 (3 ♀, Biserat, Siam, off *Varanus salvator*).

Amblyomma javanense Schulze, 1934, Zeitschr. f. Parasitenk., **7**, pt. 2, p. 167 (6 ♂, 1 ♀, 1 n, Pangrango, Java, off *Manis javanica*); 1936, Zeitschr. Morph. Oekol. Tiere, **32**, pt. 2, p. 206, fig. 23c (morphological); 1938, *Op. cit.*, **34**, pt. 1, p. 139, figs. 3, 7 (♀, Hainan); 1939, Zeitschr. f. Parasitenk., **10**, pt. 6, p. 728 (Burma).

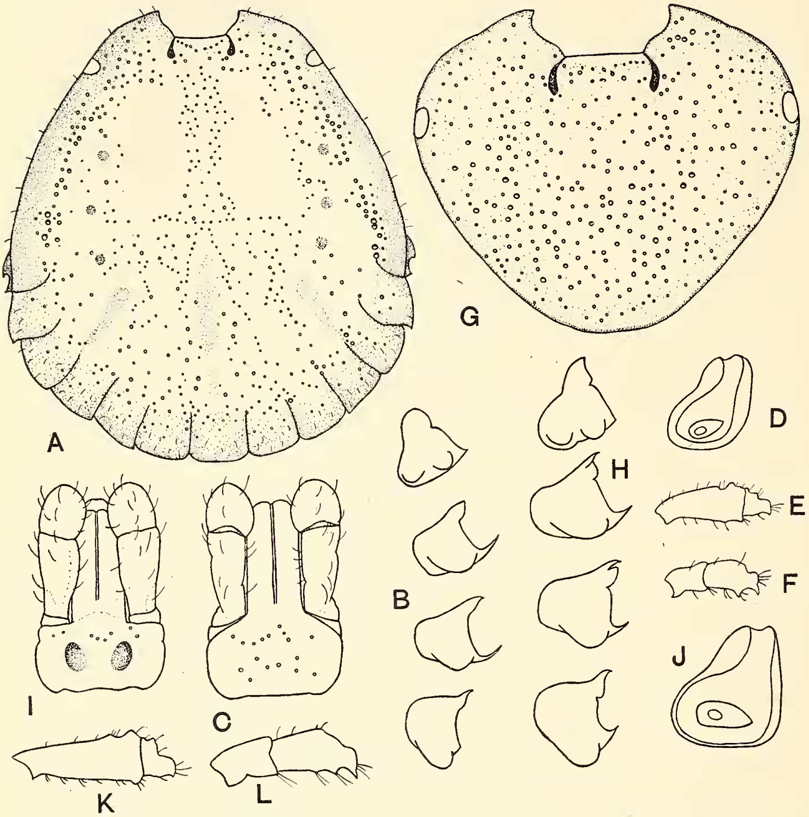

Fig. 22. *Amblyomma javanense* (Supino). A–F, male: A, scutum B, coxae I–IV; C, capitulum; D, spiracle; E, tarsus I; F, tarsus IV. G–L, female: G, scutum; H, coxae I–IV; I, capitulum in dorsal view; J, spiracle; K, tarsus I; L, tarsus IV.

Amblyomma javanense javanense Schulze, 1937, *Op. cit.*, 9, pt. 6, pp. 690–692, fig. 2.

Amblyomma compressum javanense Schulze, 1941, Zeitschr. Morph. Oekol. Tiere, **37**, pt. 3, p. 514 (morphological).

In 1937 Schulze believed that a relationship existed between the ticks found on the ant-eaters of Africa and of South Asia, and he regarded them as subspecies. *Amblyomma javanense* is the tick found on the Asiatic ant-eaters and *Amblyomma cuneatum* occurs on African ant-eaters. Schulze used the name *A. javanense javanense* (Supino) for the Asiatic form and *A. javanense cuneatum* Neumann for the African form. In 1941 to further complicate matters he decided that *A. compressum* (Macalister) was an older name for *A. cuneatum* Neumann. In giving the former name priority he changed *A. javanense javanense* to *A. compressum javanense.* I examined specimens of *A. cuneatum* in the Museum of Comparative Zoölogy from the Gold Coast, West Africa; it is probable that *cuneatum* and *javanense* had a common origin, but they are so distinct now that they must be regarded as separate species.

Since no specimens are available from Indonesia, specimens from the Philippine Islands are used for the description of the male and the female.

Male (Fig. 22A–F). Seven specimens from 5.4 to 4.8 mm. long to 4.8 to 4.05 mm. wide, exclusive of capitulum; average 5.2 mm. long by 4.52 mm. wide. Scutum inornate, maroon-brown in peripheral regions and yellow-brown in central region; punctations unequal, sparsely distributed in periphery and almost entirely absent in anterior and median portion; lateral groove as linearly arranged punctations extending two-thirds distance to eyes; cervical grooves very small and inverted comma-shaped; few, short, white hairs in region of festoons; eyes small and indistinct; festoons large and distinct. Ventral body surface yellow, finely wrinkled, with numerous, fine punctations, and very short, indistinct hairs; genital opening opposite coxa two; anal opening opposite posterior border of spiracle; anal groove very distinct; spiracular plate long and comma-shaped. Legs brown-maroon, strong and relatively short; coxa I with two short, broad and widely separated spurs; coxae II–IV with a single very broad and flat spur; tarsi short, terminating abruptly and with prominent terminal and sub-terminal spurs; claws very long, nearly three times as long as pulvillus. Capitulum relatively short; basis rectangular, with lateral edge slightly convex; palps short and club-shaped; article two about one and a half times as long as article three; hypostome short and broad; dentition 3:3, with six to eight teeth per file.

Female (Fig. 22G–L). Largest of four slightly engorged specimens, exclusive of capitulum, 6.0 mm. long by 4.8 mm. wide, smallest 5.0 mm. long by 4.2 mm. wide. Body nearly circular, narrowed slightly in region of eyes. Scutum dark brown, inornate, from 2.4 to 2.1 mm. long by 3.0 to 2.5 mm. wide, average 2.19 mm. long by 2.8 mm. wide, cordiform with rounded angles, slightly wider than long and with postero-lateral margins very slightly concave; punctations numerous, shallow, small to medium and evenly distributed; cervical grooves small and inverted comma-shaped; marginal groove distinct, ending near scutum; eyes small and often indistinct. Abdomen with scattered, medium punctations and white hairs; festoons prominent, slightly longer than wide. Body ventrally with numerous, medium punctations and with short, white hairs on posterior two-thirds; genital opening opposite coxae II–III; anal opening opposite posterior margin of spiracular plate; spiracular plate comma-shaped, slightly broader than that of male. Legs more slender than those of male; coxal spurs as in male. Basis wide, with sides slightly convex; porose areas deep, oval, small and divergent anteriorly; palps short and club-shaped; hypostome short; dentition 3:3, with eight to ten teeth per file.

Distribution, Hosts and Biology. This species is widely distributed in the Orient, and is known from Siam, China, Tenasserim, Burma, Ceylon, Indochina, Fed. Malay States, India and the East Indies. It has been recorded from Sumatra (Neumann, 1901) and Java (Neumann, 1901; Krijgsman and Ponto, 1931, 1932; Schulze, 1934). No specimens were seen from Indonesia, but I saw five lots of many males, females, nymphs and larvae from the Philippine Islands in the Rocky Mountain Laboratory. In addition I saw in the Museum of Comparative Zoölogy two females taken off *Manis* sp. in China.

Most of the known host records for this tick are from species of *Manis,* but it occasionally attacks reptiles. Neumann in 1899 recorded a male off *Python molurus;* Cooper and Robinson in 1908 recorded it off *Varanus salvator;* and Sharif in 1928 recorded it off *Geoemyda tricarinata* in India. Robinson in 1926 recorded a nymph off *Hyaena hyaena* in India. All stages are found on *Manis,* and *A. javanense* is apparently a one host tick.

Amblyomma malayanum Neumann.

Amblyomma malayanum Neumann, 1908 (March 20), Arch. de Parasit., **12,** pp. 14–16, 26, figs. 9–10 (1 ♂, 2 ♀, Bukitima, Singapore; types in British M.); 1908, Notes Leyden Mus., **30,** p. 86 (1 ♂, 1 ♀, Malayan Peninsula, off tortoise). Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1,** Acariens, p. 132. Neumann, 1911, Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 56, 59, 64, 68, 89.

Amblyomma caelaturum Cooper and Robinson, 1908 (July 16), Proc. Cambridge Philos. Soc., **14,** pt. 5, pp. 460–462, figs. 6–9 (2 ♂, 1 ♀, Kwala Aring, Java [*sic*], off *Geoemyda spinosa;* cotypes in Brit. Mus.). Robinson, 1926, Ticks, **2,** pt. 4, *Amblyomma,* pp. 17, 21, 227–230, figs. 111–112 (type locality corrected to Kuala Aring, Federated Malay States; ♂, ♀, Malay Peninsula, off tortoise). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, map 4; 1932, Veeartsenijk. Meded., No. **79,** pp. 23, 35, figs. 31–32, map 4 (Sumatra, off reptiles). Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pt. 2–3, pp. 510, 511, fig. 2 (1) (morphological); 1936, Meddel. Zool. Mus., Oslo, No. **13,** p. 160 (morphological). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 116, 119, Pls. 82, 84.

Amblyomma caelaturum caelaturum Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pts. 2–3, p. 512.

Amblyomma caelaturum perfectum Schulze, 1932, Zeitschr. f. Parasitenk., **4,** pt. 3, pp. 469–470, fig. 6 (4 ♂, Soekaranda, Sumatra); 1932, Zeitschr. Morph. Oekol. Tiere, **25,** pts. 2–3, pp. 512, 520.

? *Amblyomma cyprium* Toumanoff, 1944 [in part: *nec* Neumann, 1899] Les Tiques (Ixodoidea) de l'Indochine, pp. 106–111, Pl. 78, figs. a, b, Pl. 79 [only description and figures of female, *nec* male].

Neumann described *A. malayanum* in 1908 from one male and two females from Bukitima, Singapore, in the British Museum. This description was published March 20, 1908. He also recorded in April, 1908, another male and female from the Malayan Peninsula collected by H. E. Durham.

Cooper and Robinson described this same species in 1908 as *Amblyomma caelaturum* from a male and a female collected at

Kuala Aring, Federated Malay States. The date of publication for this name was July 16, 1908. Robinson in his monograph of the genus in 1926 incorrectly gave priority to *A. caelaturum.* The name proposed by Neumann is the oldest name, and it has priority over that proposed by Cooper and Robinson. In 1932 Schulze divided this species into two subspecies, *A. caelaturum caelaturum* and *A. caelaturum perfectum.* His new subspecies is based upon four males from Soekaranda, Sumatra, and it differs from the typical form in the relation between musculature and scutum. The male of *perfectum* is supposed to have porose areas like the female. These characters are tenuous, and the claim that the male of this species has the porose areas, which are attributes of female ticks only, is incorrect. I examined specimens in my possession, and though I found the posterior portion of the basis capituli to be finely punctate, in no way does it bear any resemblance to the porose areas. Similar punctation also occurs on the basis of *A. cyprium.*

Toumanoff in 1944 has figured as the female of *A. cyprium* a female resembling *A. malayanum;* however, it differs in the shape of the scutum, the porose areas, the spiracle and the spur of coxa IV.

Since specimens are not available for study from Indonesia, material from the Philippine Islands is used for the description of the male and female.

Male (Fig. 23A–F). Two unengorged specimens respectively 5.55 and 6.66 mm. long by 4.95 and 6.15 mm. wide. Scutum nearly circular, slightly longer than wide and narrowed anteriorly in region of the eyes; pseudoscutum well defined and lighter than scutum; punctations medium, numerous, deep and slightly confluent; pale, enamel markings anterior to the eyes, and a very small, pale marking in posterior angle of pseudoscutum; cervical grooves short, deep and extending as elongated, shallow, wide depressions posteriorly; a median, narrow, longitudinal elevation beginning near median festoon and continuing anteriorly toward pseudoscutum; a narrow, smooth elevation beginning opposite second and third festoons on each side and continuing obliquely toward median elevation; three elevations anterior to these oblique elevations on each side; all elevations free of punctations; lateral groove composed of numerous linearly arranged punctations; eyes brown, small, flat, and indistinct; festoons longer than wide. Ventral body surface with many, fine wrinkles and numerous, small punctations; short, white hairs restricted to posterior third; spiracular plates very

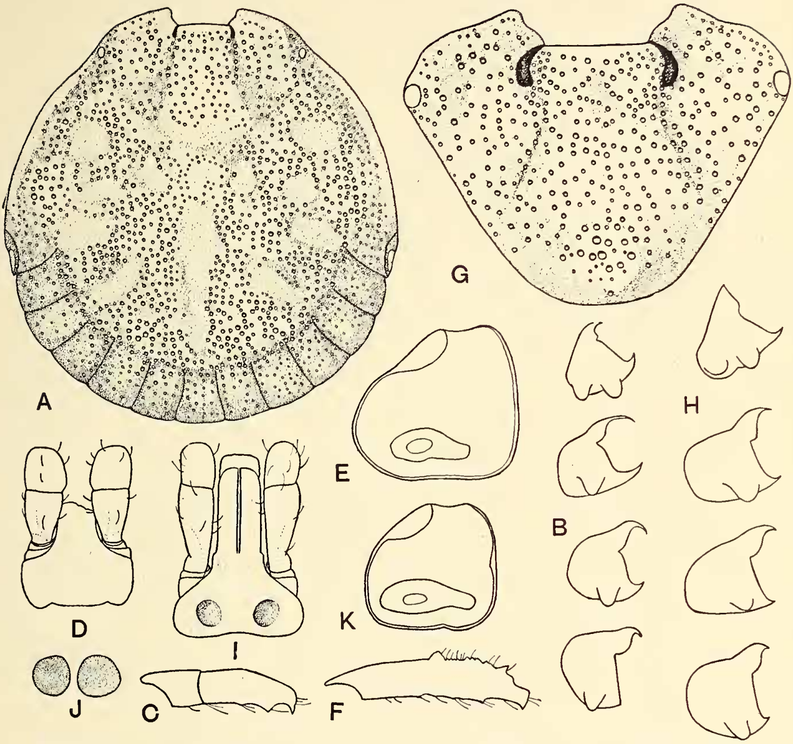

Fig. 23. *Amblyomma malayanum* Neumann. A–F, male: A, scutum; B, coxae I–IV; C, tarsus IV; D, capitulum; E, spiracle; F, tarsus I. G–K, female: G, scutum; H, coxae I–IV; I, capitulum in dorsal view; J, dorsal foveae; K, spiracle.

large and broad; genital opening opposite coxa II; anal opening opposite posterior portion of spiracles. Legs fairly slender, long, and lighter in color than body; pale markings dorsally on distal end of femur, tibia and protarsus; coxae small; coxa I with two short, nearly equal spurs; remaining coxae with a single, short spur; tarsi II–IV long and with prominent terminal and sub-terminal spurs. Capitulum relatively short; basis rectangular, with posterior margins slightly salient; hypostome short and slightly spatulate; dentition 4 : 4; palps short and club-shaped.

Female (Fig. 23G–K). Largest of two engorged specimens 12 mm. long, 9.9 mm. wide and 6 mm. thick. Triangular scutum from 2.7 to 2.7 mm. long by 3.6 to 3.48 mm. wide, angles rounded, with posterior angle very broad, sides nearly straight, antero-lateral margins prominent; brownish-maroon, a small pale marking in each scapular angle, and a rounded spot in posterior angle; punctations numerous, deep, unequal and uniformly distributed, with those in region of eyes slightly larger; cervical grooves deep, prominent anteriorly, enlarging into wide, shallow depressions posteriorly; eyes small, pale and not very prominent. Body reddish-brown, with many, small punctations and short, thick, white hairs; dorsal foveae very large, ovoid, slightly elongate transversely, 0.30 mm. long by 0.35 mm. wide, with surface hard, shining and dotted with very fine punctures; festoons about as long as broad, with posterior half free of hairs. Ventral body surface similar to that of male; spiracles large and broad. Legs and coxae as in male. Capitulum broader than long, with posterior border slightly concave; porose areas large, deep, oval, slightly divergent in front, with interval between porose areas slightly wider than their diameter; hypostome long, with 4 : 4 dentition; palps longer than those of male; article two slightly over twice as long as article three.

Distribution and Hosts. This species, which is rare in collections, is known from Bukitima (Singapore), Kuala Aring (Federated Malay States), and Soekaranda (Sumatra). Two males and two females were seen in the Museum of Comparative Zoölogy. These were taken off a tortoise in the Philippine Islands, and where host records are known, all are from tortoises.

Amblyomma robinsoni Warburton.

Amblyomma robinsoni Warburton, 1927, Parasitology, **19**, pt. 4, pp. 408–409, Pl. 27, figs. 1–2 (8 ♂, 3 ♀, Komodo Is., off *Varanus komodoensis;* cotypes probably in Brit. Mus. and at Zool. Mus. Buitenzorg). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, map 4; 1932, Veeartsenijk. Meded., No. **79,** pp. 23, 34, 35, figs. 35–36, map 4. Whittick, 1939, Parasitology, **31,** pt. 4, pp. 436, 437, figs. 3–4 (3 ♂, 1 dwarf ♂, Zool. Gardens, London, off *Varanus komodoensis*). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 105–106, 118, 120, Pls. 75–77 [in part: only figure and description of ♂ taken from Krijgsman and Ponto, 1932; *nec* those of ♀, which is *A. supinoi* Neum.].

Toumanoff recorded one female from Haut-Chlong, Indochina, but it does not agree with Warburton's description nor with five female specimens in my possession. It differs from *robinsoni* in the shape of the scutum, the punctations, and in the number of the spurs on coxa III. Toumanoff stated in his description and showed in his figure that there are two spurs on coxa III; only one spur is found on coxa III in *robinsoni.* The female figured by Toumanoff resembles *A. supinoi* Neumann; the male is taken from Krijgsman and Ponto. It may be assumed that he never saw specimens of *A. robinsoni,* and that this species probably does not occur in Indochina.

Male (Fig. 24A–F). Eleven slightly engorged Komodo specimens from 6.3 to 4.35 mm. long by 4.65 to 3.45 mm. wide; average 5.53 mm. long by 4.27 mm. wide; measurements given by Warburton are too small. Scutum longer than wide, narrowed slightly in region of eyes, chocolate-brown and set off by a characteristic, broad, lateral, rose-gold band beginning in scapular angles, skirting eyes and continuing around margin of body, being interrupted in region of festoons by groove between each festoon; a pale marking in posterior angle of region corresponding to pseudoscutum; pseudoscutum not otherwise indicated; pale markings of varying distinctness in posterior region of body; punctations numerous, large and shallow, forming a reticulate pattern, more pronounced laterally, posteriorly and in median area; cervical grooves short, deep and nearly parallel; eyes small, flat, yellow, with a dark border; no lateral grooves. Ventral body surface yellow, finely wrinkled, punctate, with hairs more prominent in posterior third; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate; spiracular plate long and narrow, with sides nearly parallel. Legs chocolate-brown, long and well developed; enamel marking dorsally on distal end of trochanter, femur, tibia and protarsus of leg I; on remaining legs marking absent on trochanter; coxa I with two subequal spurs, external about twice as long as internal spur; coxa II with two spurs, internal very small; coxae III–IV with single spur equal to external spur of coxa II; tarsi rounded, not tapering appreciably and ending in a distinct terminal and sub-terminal spur; pulvillus about one-half as long as claws. Capitulum not long in proportion to size of tick, being 1.8 mm. long; basis triangular, with lateral edges slightly convex; cornua weakly developed; two specimens with faint, enamel markings on basis; palps short, rugose and club-shaped; hypostome nearly as long as palps; dentition 4 : 4 throughout length, with nine to ten teeth per file.

Female (Fig. 24G–L). Five slightly engorged Komodo specimens from 6.3 to 5.4 mm. long by 4.65 to 4.05 mm. wide, exclusive of capitulum. Scutum cordate, slightly broader than long, from 2.88 to 2.7 mm. long by 3.3 to 3.0 mm. wide, average 2.84 mm. long by 3.13 mm. wide; reddish-brown, ornate with three rose-gold spots of variable size and shape; lateral spot in each corner of scutum larger and more elongate than one in posterior angle; eyes dull and flat; punctations numerous, coarse and slightly confluent; in some, posterior border without punctations; cervical grooves short, deep and slightly convex externally, continuing posteriorly as shallow depressions. Abdomen orange-brown, punctate and with short hairs; dorsal foveae conspicuous, circular and close together; posterior, median groove beginning a short distance behind foveae and extending to festoons; two postero-lateral grooves converge toward median; festoons nearly free of punctations and about as broad as long; grooves separating festoons deep and narrow. Abdomen ventrally yellow, punctate and with hairs more apparent in posterior third; genital opening opposite coxa II; anal opening opposite spiracular plate; spiracular plate sub-triangular, with macula long and distinct. Legs similar to those of male. Capitulum 1.8 mm. long; basis sub-triangular, with rounded corners and short, blunt cornua; porose areas small, oval and widely separated; hypostome dentition 4 : 4, with ten to eleven teeth per file.

Distribution, Hosts and Biology. This species is apparently restricted to *Varanus komodoensis* on Komodo Island as is indicated by the existing records (Warburton, 1927; Whittick, 1939). Several males comprising two lots were seen in the Rocky Mountain Laboratory; these were taken off a Komodo lizard in the New York Zoo, New York City, by Dr. C. V. Noback in 1934. One male was seen in the Museum of Comparative Zoölogy evidently from the same lot; it was taken off *Varanus komodoensis* at the New York Zoo by Dr. Noback and presented to Dr. T. Barbour. In the collection of the American Museum of Natural History were seen seven males and five females from Komodo Island collected June, 1925, without indication of host.

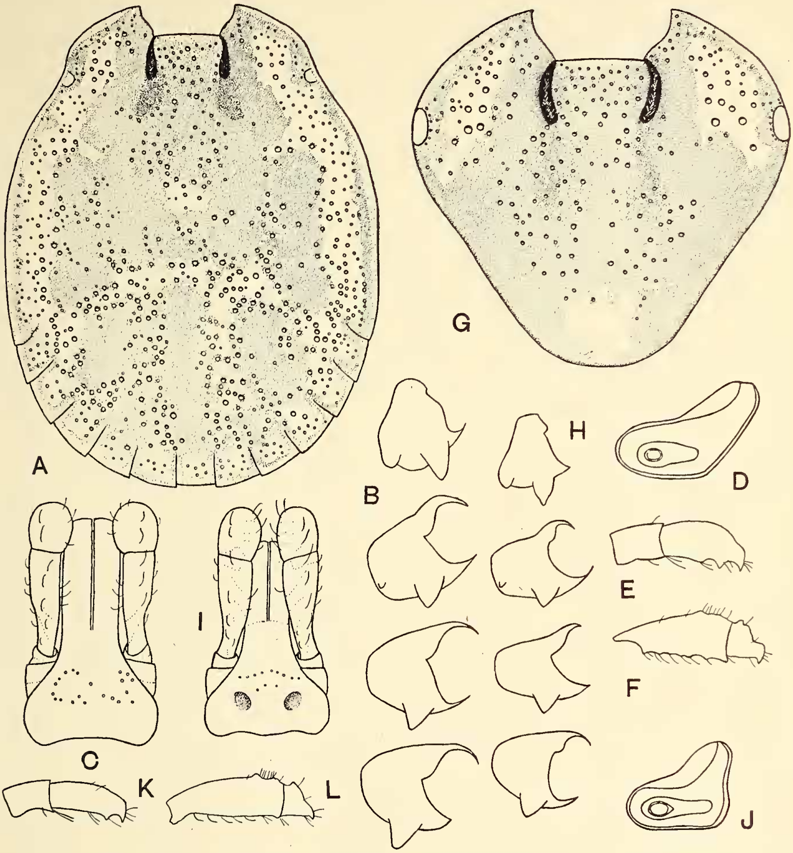

Fig. 24. *Amblyomma robinsoni* Warburton. A–F, male: A, scutum; B, coxae I–IV; C, capitulum; D, spiracle; E, tarsus IV; F, tarsus I. G–L, female: G, scutum; H, coxae I–IV; I, capitulum in dorsal view; J, spiracle; K, tarsus IV; L, tarsus I.

Amblyomma testudinarium C. L. Koch.

Amblyomma testudinarium C. L. Koch, 1844, Arch. f. Naturgesch., **10**, pt. 1, p. 226, No. 13 (♂, Java; type in Berlin M.); 1847, Uebersicht des Arachnidensystems, **4**, pp. 17, 67–68, Pl. 11, fig. 40. Neumann, 1899, Mém. Soc. Zool. France, **12**, pp. 202, 205, 240–242 (1 ♂, 2 ♀, Mountains of Chaudoc, Cochin China; 2 ♂, Java, off *Tapirus indicus* and *Rhinoceros sondaicus;* 1 ♂, unknown locality; 1 ♀, Borneo); 1901, *Op. cit.*, **14**, pp. 303 (2 ♀, Annam, off tiger; 2 ♀, Ceylon; 4 ♂, 5 ♀, Borneo, off *Sus barbatus;* 1 ♀, Java; 1 ♂, Java, off "*Sus vittatus*" = *Sus cristatus vittatus;* 7 ♀, Java, off "*Buffelus indicus*" = *Bos bubalis bubalis*). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 473, 474. Koningsberger, 1903, Veeartsenijk. Blad. v. Nederl.-Indië, **15**, pt. 2, p. 146, fig. 6. Blanchard, 1909, L'Insecte et l'Infection, Fasc. **1**, Acariens, p. 134. Warburton, 1910, Parasitology, **3**, pt. 4, p. 396 (Sikkim and Sibsagar, Assam). Neumann, 1911, Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 56, 58, 64, 67, 86–87 (♂, ♀, Java, Sumatra, Borneo, Cochin China, Annam, Ceylon, off *Felis tigris, Potamochoerus larvatus*); 1913, Supplementa Entomologica, Berlin, **2**, p. 135 (1 ♂, Taihorin, off *Manis dolmanni;* 11 ♂, ♀, Kosempo, off wild pig). Kishida, 1922, Zool. Mag., Tokyo, **34**, No. 408, pp. 850, 851, 856. Warburton, 1925, Spolia Zeylanica, **13**, pt. 2, p. 256 (Colombo, Ceylon, from bush). Larrousse, 1925, Ann. Parasit. Hum. et Comp., **3**, pt. 3, p. 301 (1 ♂, Nhatrang, Annam, off cervide probably "*Cervulus muntjak*" = *Muntiacus muntjak*). Warburton, 1926, Treubia, **8**, pts. 3–4, p. 280 (♀, n, Andalos (Tandjoeng) Sumatra's west coast, Pandang Island, Boö Island, off *Martes flavigula henrici*). Robinson, 1926, Ticks, **2**, pt. 4, *Amblyomma*, pp. 17, 23, 253–257, figs. 125–126 (extensive host and distribution lists). Sharif, 1928, Records Indian Mus., **30**, pt. 3, pp. 330–333, figs. 46–47 (♂, ♀, n, Burma, Assam, Bengal, Bombay, Coorg State, Ceylon, off bullock, *Felis tigris*, Nelore cow, Sambar deer). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., **4**, pt. 1, pp. 141, 143, map 4; 1932, Veeartsenijk. Meded., No. **79**, pp. 20–21, 35, figs. 23–24, map 4 (♂, ♀, Sumatra, Bali, Lombok, Soemba, Java, Borneo, off buffalo, cow, man, and "*Sus vittatus*" = *Sus cristatus vittatus*). Sugimoto, 1935, Taiwan-No-Chikusan, **3**, pt.

9, p. 7; 1936, *Op. cit.*, **4**, pt. 2, pp. 4–7, Pl. 6, figs. 1–7, Pl. 8, figs. 1–4; 1936, Journ. Cent. Soc. Vet. Med., Tokyo, **49**, pt. 7, p. 584, pl. 3, figs. 1–7; 1936, Journ. Soc. Trop. Agric., Tokyo, **8**, pt. 4, p. 337 (Formosa). Ogura, 1936, Mem. Fac. Sci. Agric., Taihoku Imp. Univ., Formosa, **19**, pt. 2, pp. 79–81, figs. 13–18 (♂, ♀, Formosa, off cattle, water buffalo, pig and wild boar). Sugimoto, 1937, Trans. Nat. Hist. Soc. Formosa, **27**, No. 160, pp. 1–6, Pl. 1, figs. 1–6, Pl. 2, figs. 1–5 (nymph and larva from Formosa); 1937, Journ. Jap. Soc. Vet. Sci., **16**, pt. 1, pp. 11–16, Pl. 5, figs. 1–6, Pl. 6, figs. 1–5; 1937, Journ. Cent. Soc. Vet. Med., Tokyo, **50**, pt. 5, pp. 318–322 (synonymy, distribution, hosts, Formosa); 1937, Journ. Soc. Trop. Agric., Tokyo, **9**, pt. 3, p. 287. Sharif, 1938, Indian Journ. Vet. Sci. and Anim. Husb., **8**, pt. 4, p. 363 (disease transmission). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 102–104, 119, 120, Pls. 69–71, 75 (♂, ♀, Indochina, off Sambar deer, tiger cat, wild pig, dog, horse; 1 n, off wild cock).

Amblyomma infestum C. L. Koch, 1844, Arch. f. Naturgesch., **10**, pt. 1, p. 226, No. 12 (♂, ♀, Bintan Island; types in Berlin M.); 1847, Uebersicht des Arachnidensystems, **4**, pp. 17, 68–70, Pl. 12, figs. 41–42. Schulze, 1935, Zool. Anz., **112**, pts. 9–10, p. 234; 1939, Zeitschr. f. Parasitenk., **10**, pt. 6, p. 728 (Burma).

Ixodes auriscutellatus Konigsberger, 1901, Teysmannia, **11**, pt. 1, pp. 61–62, figs. 7–8 (♂, ♀, Bandong and Buitenzorg, Java, off buffalo; location of types unknown).

Amblyomma compactum Neumann, 1901, Mém. Soc. Zool. France, **14**, pp. 296–297, 342 (2 ♀, Sumatra; cotypes in Berlin M.).

Amblyomma infestum testudinarium Schulze, 1932, Zeitschr. f. Parasitenk., **4**, pt. 3, pp. 467–469 (4 ♂, 4 ♀, Soekaranda, Sumatra); 1932, Zeitschr. Morph. Oekol. Tiere, **25**, pts. 2–3 pp. 528–529 (morphological); 1941, *Op. cit.*, **37**, pt. 3, p. 514 (morphological).

Amblyomma infestum infestum Schulze, 1932, Zeitschr. f. Parasitenk., **4**, pt. 3, pp. 468, 469 (based on Koch's types from Bintan Island near Singapore). Bequaert, 1933, Psyche, **40**, pt. 4, pp. 140–142 (1 ♂ 3 ♀ Bernam River, Selangor, Fed. Malay States, off *Rhinoceros sumatrensis*). Schulze, 1936, Zeitschr. Morph. Oekol. Tiere, **32**, pt. 2, pp. 204, 206, 207, fig. 19 b (morphological).

Amblyomma fallax Schulze, 1932, Zeitschr. f. Parasitenk., **4**, pt. 3, p. 468 (*nomen novum* for *A. testudinarium* as described and figured by Robinson, 1926, pp. 253–257). Bequaert, 1933, Psyche, **40**, pt. 4, p. 141.

Amblyomma infestum taivanicum Schulze, 1935, Zool. Anz., **112**, pts. 9–10, pp. 234, 236–237, fig. 2 (♂, ♀, Kosempo, Formosa, off dog; holotype ♂ in D. Ent. Inst. Berlin-Dahlem).

Amblyomma infestum borneense Schulze, 1936, Zeitschr. f. Parasitenk., **8**, pt. 6, pp. 623–624, fig. 4 (3 ♂, 3 ♀, Borneo, off *Sus verrucosus;* holotype ♂ in Z. M. Berlin).

Haemalastor infestum Oudemans, 1936, Krit. Hist. Overzicht Acarologie, **3**, Bd. B, pp. 497–499, fig. 202.

Haemalastor infestum var. *testudinarium* Oudemans, 1936, *Op. cit.,* pp. 544–545, fig. 225.

In 1844 C. L. Koch described *A. infestum* from Bintan Island and *A. testudinarium* from Java in the same publication as distinct species. Neumann, as first reviser, made *A. infestum* a synonym of *A. testudinarium* even though *A. infestum* had line priority. Schulze in 1932 reversed the names making *A. testudinarium* a synonym of *A. infestum.* Neumann gave no reasons for choosing the name *A. testudinarium* over *A. infestum,* but since he was the first reviser, the choice of which name to use was up to him. No case can be made for line priority in this situation, and since the name is now firmly established in the literature, no good purpose would be served by reviving the name *A. infestum.*

In 1932 Schulze stated that the male described and figured by Robinson in 1926 on page 254 as *A. testudinarium* is not that of Koch; he regarded it as a new species, and he gave it the name *Amblyomma fallax.* He said that it differed from *A. testudinarium* in that ventral muscle scutes were present and that the peltae were obliquely or diagonally placed. Schulze, however, has misinterpreted the drawing in regard to the peltae. Robinson in figure 125 has not depicted the salience of the peltae at the postero-internal angle, because it is impossible to see the peltae when the specimen is viewed from the ventral position; it is necessary to raise the posterior end of the specimen and to look down on the posterior margin in order to see the salience of the peltae. In Robinson's figure the peltae run parallel with the festoons, and this is shown by the solid lines which represent both the lateral margin of the festoons and the peltae. Robinson merely shows the dark brown, ventral scutes of which the internal, lateral border is oblique. The drawing is misleading, however, for the solid lines representing a portion of the border of the muscle scutes could easily be mistaken for oblique peltae. Specimens were seen where the ventral muscle scutes are missing entirely and others where they are only slightly developed, but the majority of those examined show well developed ones. For these reasons I believe that the name *A. fallax* Schulze is unnecessary and that it should be regarded as a synonym of *A. testudinarium.*

Schulze attempted to separate *A. infestum* and *A. testudinarium* as distinct races in 1932, but I can not agree with this division. The characters used by Schulze to separate these races are color, pattern of the ornamentation and size. All of these characters are known to vary widely and have little, if any, taxonomic value. Numerous specimens were seen from Burma, Assam, Formosa, the Philippine Islands, India, China, Siam, the Federated Malay States and the East Indies, and I am convinced that they are all the same species. I compared specimens from Formosa with the description and figures given by Schulze for *A. infestum taivanicum,* and I am convinced that this is the same as *A. testudinarium.* I saw no material from Borneo, but the description and figures given by Schulze for *A. infestum borneense* show that it is also *A. testudinarium.* Both these subspecies should be considered as synonyms of *A. testudinarium.*

Male (Fig. 25A–G). Numerous, unengorged specimens from Sumatra, Java, Celebes, Flores from 6.42 to 5.4 mm. long by 6.0 to 5.1 mm. wide, exclusive of capitulum. Body broad-oval, and narrowed anteriorly. Scutum yellow-orange and light-brown, some more ornate than others; punctations numerous, large and irregularly distributed, with a slight confluency in region immediately anterior to festoons; elevations present generally free of punctations; cervical grooves short, deep and comma-shaped; eyes large, yellow and flat. Festoons distinct and longer than wide, with interval between them wide. Ventral body surface yellow, finely wrinkled and with numerous, small punctations; genital opening opposite coxa II; anal opening opposite posterior margin of spiracular plate; spiracular plate comma-shaped and obliquely placed; muscle scutes in region of festoons dark brown; peltae parallel to festoons and postero-internal angle slightly salient. Legs long and stout, with a faint, circular marking at distal end of each joint; coxa I with two long, subequal spurs, external spur slightly longer; coxae II and III each with a broad, single, rounded spur; coxa IV with a single spur about twice as long as wide; tarsi short, ending in a distinct terminal and sub-terminal spur; pulvillus about one-half as long as claws. Capitulum long; basis rectangular, with sides slightly convex and posterior margin slightly concave; palps long, with article two a little more than twice as long as article three; hypostome long and slender; dentition 4 : 4, but internal row on each side beginning about one-fourth distance from anterior tip; eight to nine teeth per file.

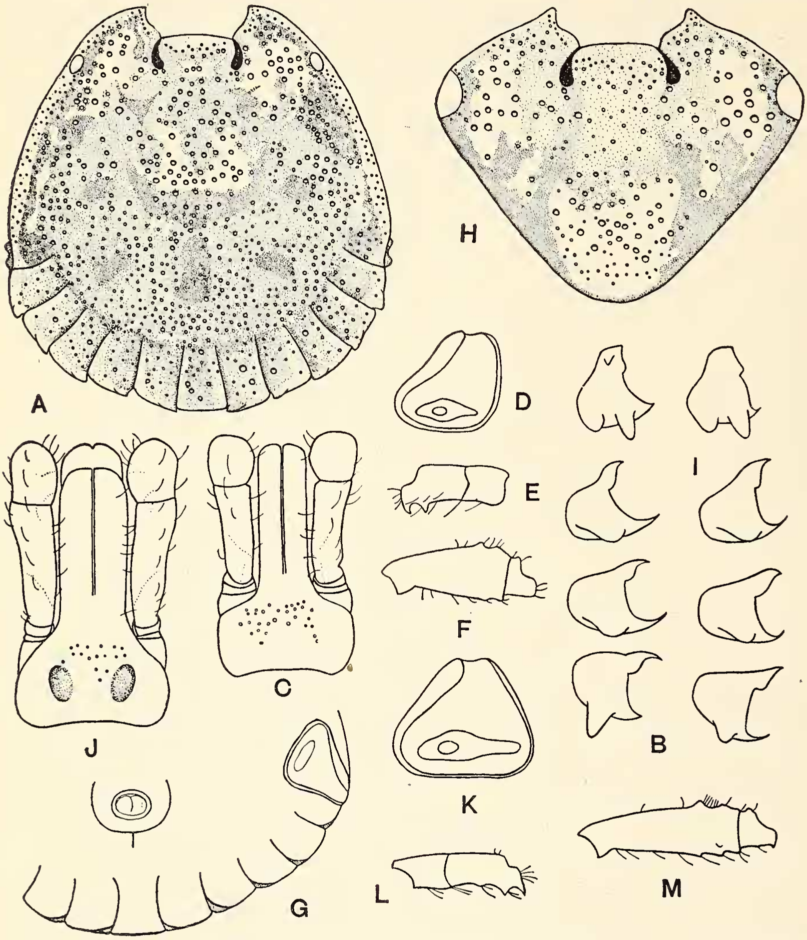

Fig. 25. *Amblyomma testudinarium* C. L. Koch. A–G, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, spiracle; E, tarsus IV; F, tarsus I; G, ventral muscle scutes, or muscle attachments. H–M, female: H, scutum; I, coxae I–IV; J, capitulum in dorsal view; K, spiracle; L, tarsus IV; M, tarsus I.

Female (Fig. 25H–M). Fully engorged specimen 25 mm. long by 18 mm. wide by 15 mm. thick. Body of unengorged female nearly circular. Scutum triangular, wider than long, posterior angle narrow, 3.15 mm. long by 3.9 mm. wide, amount and pattern of ornamentation variable; punctations unequal, irregularly distributed, with larger ones in lateral margins near eyes; cervical grooves small and comma-shaped; eyes yellow, large and conspicuous. Abdomen dorsally with numerous, large punctations and short, white hairs; dorsal foveae small, dark and conspicuous. Abdomen ventrally with numerous, fine wrinkles and many, small punctations; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate; spiracular plate large and triangular, with rounded corners. Coxae I–III with spurs similar to those of male; coxa IV with spur much shorter than that of male; tarsi longer than those of male. Capitulum long; basis rectangular, with sides slightly convex; in some specimens posterior margins slightly concave, in others straight; porose areas large, oval and parallel; hypostome long and slender; dentition 4:4; inner row with smaller teeth than other rows.

Distribution and Hosts. This species is common and is widely distributed throughout the Oriental Region; it is known from Burma, Indochina, Annam, Ceylon, Borneo, India, Federated Malay States, Formosa, Japan (?), Cochin China and the East Indies. In the East Indies it has been recorded from Java (Koch, 1844; Neumann, 1899, 1901, 1911; Koningsberger, 1900; Robinson, 1926; Krijgsman and Ponto, 1931, 1932), Sumatra (Neumann, 1901; Robinson, 1926; Krijgsman and Ponto, 1931, 1932; Schulze, 1932), Bintan Island (Koch, 1844; Schulze, 1932), Andalos, Pandang and Boö Island (Warburton, 1926), Bali (Robinson, 1926; Krijgsman and Ponto, 1931, 1932), Lombak and Soemba (Krijgsman and Ponto, 1931, 1932).

Numerous specimens were seen from the following localities: Sumatra (Lhokseumawe, off buffalo and goat; Medan, off buffalo; Padangsidimpoean, off buffalo and goat; Lahat, off buffalo and cow; all in Kraneveld collection), Java (Blitar, off buffalo; Djember, nymph, off pig, in Kraneveld collection; two females, off *Sus verrucosus*, in Museum of Comparative Zoölogy; West Java, two males, four females, off *Bos sondaicus sondaicus* collected by F. C. Kraneveld, in Museum of Comparative Zoölogy), Celebes (two females, without host; four males, off *Sus barbatus*, in Museum of Comparative Zoölogy), Flores (Roeteng, one male and one nymph, off cow, in Kraneveld collection).

Biology. All stages in the life cycle are known. The only host record for the larval stage is that of two larvae, taken off *Tupaia belangeri versurae,* in the Rocky Mountain Laboratory collection.

These ticks occur on a wide variety of wild as well as domestic animals, and they must be regarded with suspicion as possible disease vectors. Krijgsman and Ponto stated in 1932 that this species transmits piroplasmosis and anaplasmosis, and Sharif in 1938 considered this species as a possible disease vector.

Genus *Aponomma* Neumann, 1899

Key to Species of *Aponomma*

Males

1. Hypostome with 4 : 4 dentition. Coxa I with single, blunt spur, much broader than long. Scutum nearly oval and ornate. Cornua absent. Punctations unequal and restricted more to margins and ornamented regions. Median area less punctate .... *A. trimaculatum*

Hypostome with 3 : 3 dentition 2

2. Scutum inornate and brown in color. Punctations unequal and uniformly distributed. Coxa I with two distinct and separated spurs; external about twice as long as internal. Spiracles about twice as long as wide .... *A. barbouri*

Scutum ornate 3

3. Coxa I with two subequal spurs; internal slightly broader than external. Scutum decidedly broader than long. Punctations numerous, unequal and more or less uniformly distributed. Spiracles very long and narrow. Cornua very short and blunt .... *A. komodoense*

Coxa I with two distinct, short, separated spurs; external slightly longer than internal. Scutum nearly as broad as long. Punctations few, unequal and sparsely distributed. Spiracles large and almost as wide as long. Cornua small and blunt .... *A. lucasi*

Females[5]

1. Hypostome with 4 : 4 dentition. Coxa I with single, broad spur. Punctations numerous, small to medium and uniformly distributed. Scutum cordiform and ornate. *A. trimaculatum*

Hypostome with 3 : 3 dentition. Coxa I with two distinct and separated spurs 2

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[5] Female of *A. barbouri* unknown.

2. External spur of coxa I slightly longer than internal, but narrower. Spiracles about as long as broad. Scutum slightly wider than long. Punctations unequal with smaller ones more numerous. Porose areas medium, fairly deep and slightly divergent anteriorly. Basis capituli sub-triangular. *A. lucasi*

Internal spur of coxa I broader and longer than external. Spiracles long and narrow. Scutum slightly wider than long. Punctations unequal with larger ones more numerous, deeper and more or less regularly distributed. Porose areas medium, circular and deep. Basis capituli triangular. *A. komodoense*

Aponomma barbouri, new species.

This is the only inornate *Aponomma* known from Indonesia; in addition, the arrangement and number of punctations, the shape of the spiracular plate and the spurs on coxa I are distinctive.

Male (Fig. 26A–E). Three specimens respectively 3.0, 2.55 and 2.25 mm. long by 2.85, 2.55 and 2.55 mm. wide, exclusive of capitulum. Scutum light brown, inornate, about as broad as long and slightly narrowed at region opposite cervical grooves; punctations numerous, small to large and uniformly distributed; cervical grooves medium, deep and inverted comma-shaped; no depressions, elevations or marginal grooves present; few, small, insignificant hairs in region of festoons; festoons short and inconspicuous. Ven-

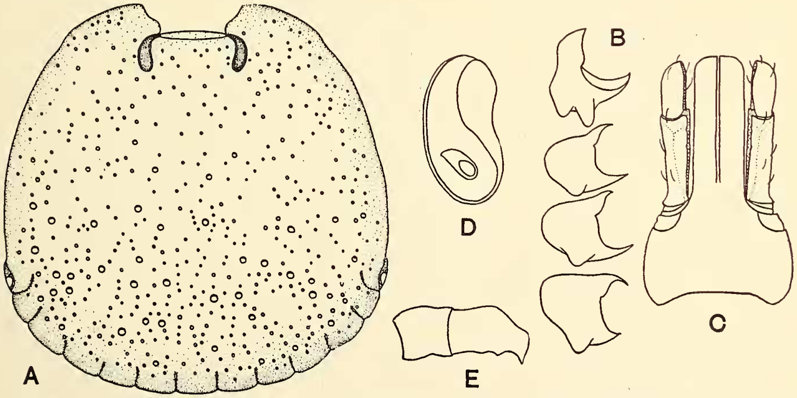

Fig. 26. *Aponomma barbouri,* new species, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, spiracle; E, tarsus IV.

tral body surface yellow with long, white hairs; spiracular plate long and narrow, with antero-dorsal edge heavily chitinised; genital opening opposite coxa II; anal opening opposite mid-portion of spiracular plate. Legs medium; coxa I with two spurs, external nearly twice as long as internal; coxae II–IV each with a distinct, median, triangular spur; tarsus I short, tapering abruptly and ending in a distinct, ventral, terminal spur; tarsus IV short, tapering gradually and with a small, sub-terminal spur and a large, terminal spur; claws about twice as long as pulvillus. Capitulum 0.84 mm. long; basis with lateral edges slightly convex and posterior border slightly concave; cornua distinct; palps short and rugose; article two less than twice as long as article three; hypostome long and slender; dentition 3:3, with approximately six teeth per file; toothed area extends posteriorly less than one-half length of hypostome.

The specimens are badly broken and in a very fragile condition. The holotype and paratypes, in the Museum of Comparative Zoölogy, were taken on *Python reticulatus* at Buitenzorg, Java, by the late Dr. Thomas Barbour, in December, 1906.

Aponomma komodoense Oudemans.

> *Aponomma komodoense* A. C. Oudemans, 1929, Zool. Meded. Leyden, **11**, pt. 4, (1928), pp. 227–231, Pl. 11, figs. 1–6, Pl. 12, figs. 7–14 (35 ♂, off *Varanus komodoensis;* cotypes at Zool. M. Amsterdam). Whittick, 1939, Parasitology, **31**, pt. 4, pp. 434–436, figs. 1–2 (23 ♂, 9 ♀, 2 n, Zool. Gardens, London, off *Varanus komodoensis*).
>
> *Aponomma draconis* Warburton, 1933, Parasitology, **24**, pt. 4, pp. 564–565, fig. 7 (3 ♂, 6 ♀, Zool. Gardens, London, off *Varanus komodoensis* from Komodo Island; types in Brit. Mus.).

The cover of part 4 of volume 11 of the ''Zoologische Mededeelingen'' is dated December 31, 1928, but according to a MS note on a reprint sent to Dr. J. C. Bequaert by Dr. A. C. Oudemans, the paper actually appeared February, 1929. The description then dates from 1929. Whittick in 1939 pointed out that the figure of coxa I given by Oudemans is inaccurate, because there are two blunt spurs present on this coxa. Dr. J. C. Bequaert in unpublished note states that he saw a male cotype from the Zoological Museum, Amsterdam, and that it does have a bifid spur. Several specimens seen from the American Museum of Natural History confirm the findings of Whittick and Bequaert.

Male (Fig. 27A–E). Scutum broader than long and broadest posteriorly in region of spiracles; four specimens, exclusive of the capitulum, from 2.9 to 2.7 mm. long by 3.15 mm. wide; yellow-green to reddish-brown with variable ornamentation; in general, a small, irregular marking on each side of cervical grooves, a small marking in center of scutum, a variable, lateral stripe on each side of scutum, and in two specimens very pale, insignificant markings on festoons. Punctations more numerous, deeper and restricted to posterior half; smaller punctations less conspicuous, shallow and more uniformly distributed; cervical grooves teardrop-shaped, short, deep and wide; no lateral grooves; festoons slightly longer than wide, punctate on anterior portion, posterior half lighter in color. Ventral body surface yellow, with numerous, short, white hairs; genital opening opposite coxa II; anal opening opposite posterior border of spiracles; spiracles unusually long and narrow; genital groove widely divergent; anal groove distinct. Legs medium and thick; some specimens with a pale marking on dorsal, distal end of each femur; tarsus I with two dorsal processes; tarsi II–IV with only one dorsal process; claws very long and slender, about three times as long as pulvillus; coxa I with two spurs, internal slightly broader and longer than external; coxae II–III with a single, small spur; coxa IV with a single spur, but slightly larger than that of coxae II–III. Capitulum 1.68 mm. long; basis triangular; cornua very short and blunt; palps long, slender and hirsute; article two nearly twice as long as article three; hypostome long and spatulate; dentition 3 : 3, with approximately nine small teeth per file.

Female (Fig. 27F–K). Single, partially engorged female nearly circular in shape, 3.3 mm. long by 3.3 mm. wide, exclusive of capitulum. Scutum light brown, cordate, wider than long, posterior angle rounded, 1.8 mm. long by 2.4 mm. wide; an irregular, ornamented spot beside each cervical groove, and a smaller spot in center of scutum; punctations and cervical grooves similar to those of male. Abdomen rugose and with large punctations; dorsal foveae small, circular and distinct; no marginal groove; festoons similar to those of male. Abdomen ventrally punctate, with numerous, short, white hairs; genital opening opposite coxae II–III; anal opening opposite spiracles; spiracles slightly broader than those of male; genital grooves widely divergent; anal groove distinct. Legs and coxae similar to those of male. Capitulum 1.05 mm. long; porose areas medium, circular, deep, with interval between them narrow; cornua short and blunt; hypostome spatulate; 3 : 3 dentition, with approximately eight, large teeth per file.

Distribution and Hosts. This species is restricted to Komodo Island and apparently is found only on reptiles. Four males and one female from Komodo Island were seen in the collection of the American Museum of Natural History. They were found in association with specimens of *Amblyomma helvolum* and *Amblyomma robinsoni,* without indication of host. According to J. C. Bequaert's unpublished notes, one male and four females taken off *Varanus komodoensis,* on Komodo Island, are found in the Chicago Natural History Museum.

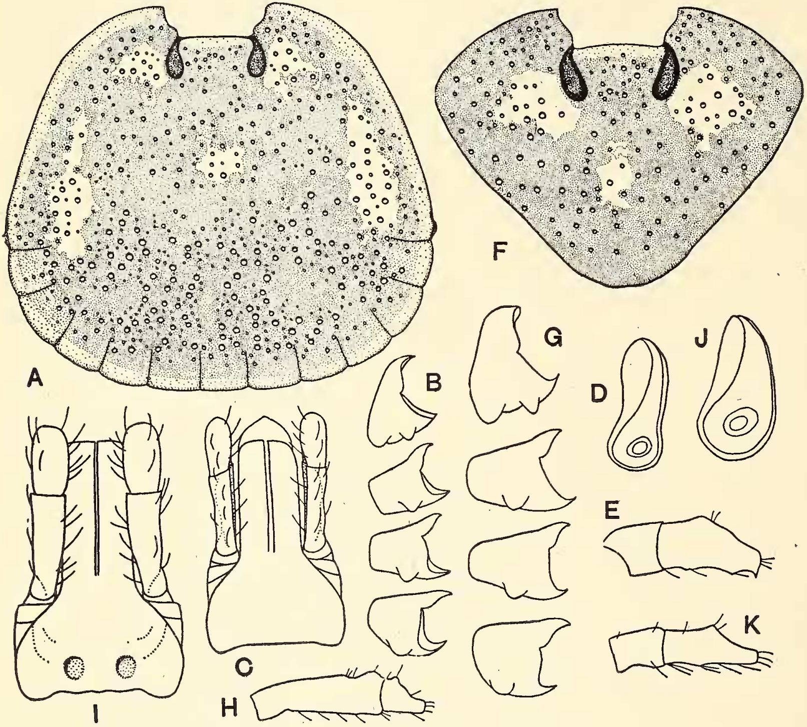

Fig. 27. *Aponomma komodoense* Oudemans. A–E, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, spiracle; E, tarsus IV. F–K, female: F, scutum; G, coxae I–IV; H, tarsus I; I, capitulum in dorsal view; J, spiracle; K, tarsus IV.

Aponomma lucasi Warburton.

Aponomma gervaisi var. *lucasi* Warburton, 1910, Parasitology, **3,** pt. 4, pp. 396, 404, 405, 406–407, fig. 10 (♂, ♀, off various reptiles in Zoological Gardens, Calcutta; type in Ind. Mus. Calcutta). Sharif, 1928, Records Indian Mus., **30,** pt. 3, pp. 337–340, fig. 49 (♂, ♀, n, l, Siam, Lower Burma, Narcondam Island, Nicobar Islands, India and Ceylon, off many hosts); 1932, *Op. cit.,* **32,** pt. 2, p. 112.

Aponomma gervaisi lucasi Schulze, 1932, Zeitschr. f. Parasitenk., **4,** pt. 3, p. 471.

Aponomma lucasi Schulze, 1933, Arch. f. Hydrobiol., Suppl. Bd. **12,** pp. 498–500 (12 ♂, 3 ♀, Ranau, Sumatra, off *Varanus salvator*); 1934, Zeitschr. f. Parasitenk., **7,** pt. 2, p. 167 (2 ♀, Tjiboeni, Java, off a coluberide); 1935, Zool. Anz., **112,** pts. 11–12, p. 330; 1936, Zeitschr. f. Parasitenk., **8,** pt. 6, pp. 631–633, 634 (India to Indonesia); 1939, *Op. cit.,* **10,** pt. 6, p. 724 (2 ♂, 4 ♀, Maymyo, Burma, off *Varanus*); 1941, Zeitschr. Morph. Oekol. Tiere, **37,** pt. 3, p. 518, fig. 30 (morphological).

Aponomma gervaisi Krijgsman and Ponto, 1931, [*nec* Lucas, 1847] Zeitschr. f. Parasitenk., **4,** pt. 1, pp. 141, 144, map 5; 1932, [*nec* Lucas, 1847] Veeartsenijk. Meded., No. **79,** p. 25, figs. 39–40, map 5 (♂, ♀, Java, off *Varanus*). Toumanoff, 1944, [in part: *nec* Lucas, 1847] Les Tiques de l'Indochine, pp. 122–124, Pl. 85.

? *Aponomma gervaisi* Neumann, 1911 [in part: *nec* Lucas, 1847] Das Tierreich, Lief. **26,** Acarina, Ixodidae, pp. 93–94 [only the Java record]. Vitzthum, 1931, Résultats Scientif. Voyage Indes Orient. Néerland. Prince Léopold, **3,** pt. 5, p. 30 (Ternate, off *Varanus indicus* and *Lophura amboinensis;* Babi, off *Varanus* sp.).

Warburton gave good characters for separating *lucasi* and *gervaisii,* but subsequent workers have confused them. Though similar in facies, these two ticks differ enough to be regarded as distinct species. Schulze in 1932 first pointed out that these supposed varieties might be distinct species; and in a series of papers from 1933 to 1939 he regarded them as such.

In the males of *gervaisii* the lateral stripe on each side is elongate and enlarged anteriorly; this enlargement may be separated from the stripe to form a distinct spot which is on a level with the cervical grooves and projects more or less into the scapular region; in some cases the lateral stripe is reduced or obsolete, but the detached enlargement still persists in the scapular region. In the males of *lucasi* the lateral stripe does not reach to the level of the cervical grooves, and the ornamentation is completely absent in the scapular region. The punctations of *gervaisii* are more equal in size and more uniformly distributed over the scutum, while those in *lucasi* are markedly unequal and less uniformly distributed. Coxa I of *gervaisii* may have a very short, blunt spur or else may have a second, smaller, inconspicuous spur internal to it; they are so near each other that they appear as a single, blunt, spur, but on careful examination there can be seen, in most cases, two distinct points, with the external slightly longer. In *lucasi* the coxal spurs are definitely separated, and they appear as two distinct spurs with the external slightly longer. The spurs of coxae II–IV in *gervaisii* are more pointed than in *lucasi*. The cornua of *lucasi* are very short and blunt, whereas *gervaisii* lacks cornua.

The females also differ in several important respects. The coxal spurs of *gervaisii* are similar to those of the male; in some cases the internal spur is so reduced that it is inconspicuous or obsolete, but in no cases were they seen to be distinctly separated. The coxal spurs of *lucasi* are also similar to those of the male; the spurs are distinct and decidedly separated. The spiracular plate of *lucasi* is wider and larger than that of *gervaisii*. The scutum of *gervaisii* has larger metallic spots and larger punctations than that of *lucasi*.

The geographical distribution of these two species also gives evidence to their distinctness. *Aponomma gervaisii* probably does not occur in the East Indies. Schulze stated in 1935 that *lucasi* is more widely distributed than *gervaisii;* he found *lucasi* to range from India to Indonesia, whereas he found *gervaisii* only in India and Ceylon. Material I have seen from numerous localities in the Oriental Region substantiates these findings.

The published records of *gervaisii* from Indonesia are all questionable; when a figure is given it is always seen to be *lucasi* and not *gervaisii*. Neumann confused several forms under this name in 1911, so his record from Java must be regarded as doubtful. Figures given by Krijgsman and Ponto in 1932 for *gervaisii* are definitely *lucasi*. Vitzthum who recorded it from the Netherlands East Indies in 1931 as *gervaisii* gave no figure or description, so it is impossible to know what he had; from the known distribution, however, it can only be *lucasi*. Toumanoff's figure of the female is misleading, for he shows the spur of coxa I to be very long; either he has a new species or his drawing is inaccurate. Toumanoff claims to have found all gradations of the spurs from *gervaisii* to *lucasi;* he further claims to have found males of one variety copulating with females of the other variety and vice versa. It is doubtful that Toumanoff had both species in his possession; he probably had *lucasi,* where some variation occurs in the form of coxa I, and he is probably referring to this variation within the species under the mistaken impression that he has both species.

Male (Fig. 28A–E). This species varies from 2.9 to 2.18 mm. long by 2.85 to 2.14 mm. wide, exclusive of capitulum. Scutum nearly as broad as long, posterior margin nearly straight, reddish-brown and with five metallic-green spots of variable thickness, shape and intensity; two lateral elongate spots not reaching cervical grooves; a single spot in median area; two posterior spots sub-triangular and close together; lateral margin completely outlined by a continuous, light brown stripe; punctations small to large, with some specimens more punctate than others; cervical grooves short, deep and convex externally; no lateral grooves; festoons set off by

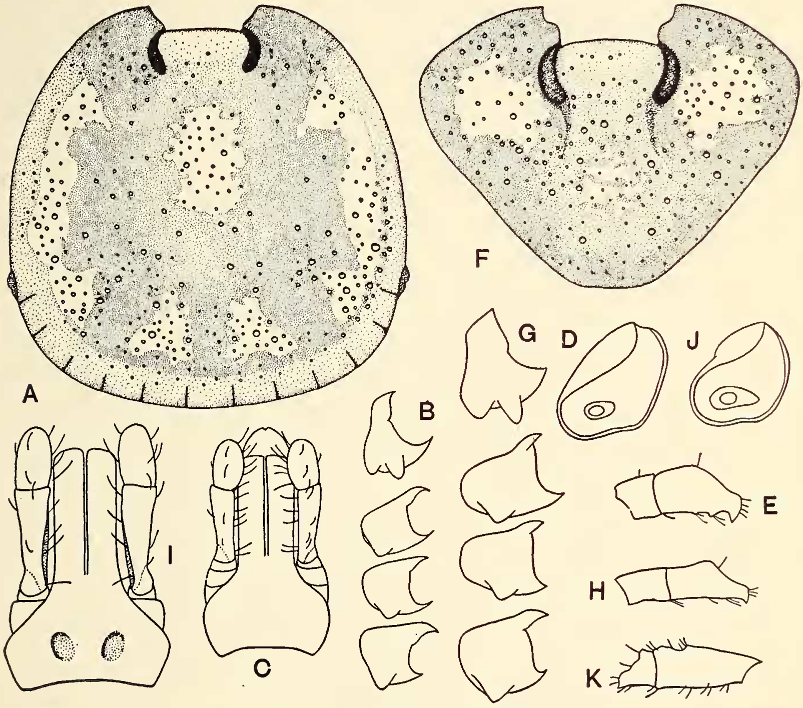

Fig. 28. *Aponomma lucasi* Warburton. A–E, male: A, scutum; B, coxae I–IV; C, capitulum in dorsal view; D, spiracle; E, tarsus IV. F–K, female: F, scutum; G, coxae I–IV; H, tarsus IV; I, capitulum in dorsal view; J, spiracle; K, tarsus I.

a light brown stripe, broader than long and without punctations. Abdomen ventrally pale yellow, with short, thick, white hairs; large, genital opening opposite coxa II; anal opening opposite spiracular plate; spiracular plate large and sub-rectangular; genital groove widely divergent; anal groove deep and distinct. Legs yellow-brown and fairly thick; tarsus I short, with three dorsal and one ventral prominence, tapering abruptly without ending in a spur; tarsi II–IV humped in middle, tapering gradually and terminating in a strong, terminal and sub-terminal spur; pulvillus small, one-third length of claws; coxa I with two short, distinct and separated spurs; external spur slightly longer than internal; coxae II–IV with a single, blunt spur about as wide as long. Capitulum 0.9 mm. long; basis sub-triangular; cornua small and blunt; palpal article two about twice as long as article three; long, white hairs on palps; hypostome spatulate; dentition 3 : 3, with approximately nine teeth per file.

Female (Fig. 28F–K). Largest of six engorged specimens 5.4 mm. long by 4.35 mm. wide, exclusive of capitulum. Scutum from 1.8 to 1.5 mm. long by 2.11 to 1.95 mm. wide, cordiform, slightly wider than long, posterior angle rounded; reddish-brown and with three greenish, metallic spots of variable size, shape and intensity; punctations unequal, with smaller ones more numerous; cervical grooves similar to those of male. Abdomen lighter than scutum and with a few, short, white hairs; postero-median groove and two postero-lateral grooves present; festoons about as wide as long and punctate; genital opening opposite coxa II; anal opening opposite spiracles; spiracles broader than those of male, but similar in shape. Legs and coxae similar to those of male. Capitulum 1.12 mm. long; basis sub-triangular; porose areas medium, fairly deep and close together; palps similar to those of male; cornua short and blunt; hypostome spatulate; 3 : 3 dentition, with approximately eight to nine teeth per file.

Distribution and Hosts. This species is distributed from India to the East Indies. It is definitely known from India, Siam, Burma, Narcondam Island, Nicobar Islands, Ceylon and the East Indies. It was recorded from Java (Neumann, 1911; Krijgsman and Ponto, 1931, 1932; Schulze, 1934), Sumatra (Schulze, 1933) and Ternate and Babi (Vitzthum, 1931).

Specimens were seen from the following localities in the collections studied: Java (Buitenzorg, eight males, four females collected by Palmer and Bryant in March, 1909; six males, one female, two nymphs off *Varanus* collected by Palmer and Bryant on March 17, 1909; thirteen males, one female off *Varanus* collected by Palmer and Bryant on March 28, 1909; four males, four females off *Varanus salvator* collected by T. Barbour; all in Museum of Comparative Zoölogy); Malay States (Singapore, four males, two females off *Naia tripudians* in New York Zoological Society, collected by T. Barbour, in Museum of Comparative Zoölogy); India (two males, one female off king cobra, collected by G. Wiley, in Museum of Comparative Zoölogy); Burma (Myitkyina, three males, three females off *Varanus monitor*, collected by G. E. Davis, May 28, 1945, in Rocky Mountain Laboratory; Maymyo, three males, two nymphs off *Varanus salvator,* in Museum of Comparative Zoölogy).

Aponomma trimaculatum (Lucas).

Ixodes trimaculatus Lucas, 1878, Ann. Soc. Ent. France, (5) **8**, Bull., pp. lxxvii–lxxviii (♀, New Guinea, off *Varanus chlorostigma;* type in Paris Museum).

Aponomma trimaculatum Neumann, 1899, Mém. Soc. Zool. France, **12**, pp. 187–188, fig. 41 (type material; 5 ♀, New Guinea, off *Varanus leucostigma;* 1 ♀, Padang, Sumatra, off *Varanus salvator*). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 470. Neumann, 1911 Das Tierreich, Lief. **26**, Acarina, Ixodidae, pp. 93, 94 [in part: only New Guinea distribution]. Warburton, 1926, Treubia, **8**, pt. 3–4, p. 279 (♂, Sinabang, Simeuloeë, off *Varanus salvator*). Krijgsman and Ponto, 1932, Veeartsenijk. Meded., No. **79**, p. 25, map 5.

Amblyomma (*Aponomma*) *primaculatum* [*sic*] Warburton, 1925, Spolia Zeylanica, **13**, pt. 2, p. 256 (Colombo, Ceylon, off *Varanus salvator*).

Amblyomma (*Aponomma*) *trimaculatum* Fielding, 1926, Comm. Austral. Service Publ. (Trop. Div.) No. **9**, p. 92, fig. 36 (after Neumann).

Aponomma undatum Schulze [*nec* Fabricius, 1775], 1932, Zeitschr. Morph. Oekol. Tiere, **25**, pt. 2–3, pp. 515, 516, 527, figs. 6c, 20, 21 (morphological); 1933, Arch. f. Hydrobiol., Suppl.-Bd. **12**, pp. 500–501, figs. 11–12, (1 ♂), Ranau, Sumatra, off *Varanus salvator;* ♂, ♀, n, Gasmata, New Britain, off *Varanus*); 1941, Zeitschr. Morph. Oekol. Tiere, **37**, pt. 3, pp. 518, 524 (morphological).

Aponomma trabeatum Schulze, 1933, Zool. Anz., **104**, pts. 11–12, pp. 322–323, fig. 7 (3 ♂, 4 ♀, Wasior, New Guinea, off *Varanus;* holotype ♂ in Z. M. Berlin).

Aponomma fimbriatum trabeatum Schulze, 1935, Zool. Anz., **112,** pts. 11–12, p. 330 (♂, Wangil Wammer, Aroe Island, off *Varanus;* 1 ♂, 2 ♀, Langemak Bay, New Guinea, off *Varanus*).

? *Aponomma trimaculatum* Neumann, 1901 Mém. Soc. Zool. France, **14,** p. 291 (1 ♀, New South Wales, off *Bos taurus*). Roberts, 1934, Queensland Agric. Journ., **42,** pt. 2, p. 123 (Townsville, Australia, off horse).

? *Aponomma gervaisi* Oudemans [*nec* Lucas, 1847], 1927, Zool. Meded. Leyden, **10,** pt. 4, pp. 222–223 (♂, ♀, Amboina, off *Varanus indicus*).

Records of *trimaculatum* from Australia (Neumann, 1901 and Roberts, 1934) and from Ceylon (Warburton, 1925) are doubtful because the distribution and hosts are not normal; neither figures nor descriptions were given for these records. It is possible that it was mistaken for *A. decorosum* (Koch), an Australian species superficially resembling *trimaculatum.*

Schulze in 1932 and 1933 considered *A. trimaculatum* (Lucas) as a synonym of *Acarus undatus* Fabricius, but the evidence for this is inconclusive. Fabricius described *undatus* in 1775 from specimens collected by Banks on Captain Cook's voyage to Australia, and he gave the locality as Nova Hollandia. Schulze may have been mislead because of the supposed occurrence of *trimaculatum* in Australia. Oudemans in 1929 stated that the description of *undatus* was based on the male of *Ixodes decorosus* Koch, placed in the genus *Aponomma* by Neumann, and I am inclined to agree with him.

Schulze described *trabeatum* in 1933 from three males and four females collected in North New Guinea. I regard it as a synonym of *trimaculatum,* for these two species resemble each other in all essential details. At first I thought that these two forms could be separated on the basis of the observed differences in the ornamentation. However, I saw somewhat later a lot of six males and one female from New Britain in which the males are intermediate in regard to the ornamentation, and one specimen is unique in showing on the left side of the body the pattern typical of *trimaculatum* and on the right side that typical of *trabeatum* (see Fig. 29B–E). The variation in the ornamentation is so great that it has no value in separating these forms. An occasional specimen of each form is often more punctate, but this is also an individual variation, for it can not be correlated with any other character.

Since material is not available from the East Indies, specimens in the Museum of Comparative Zoölogy from Munda, New Georgia, are used for the descriptions.

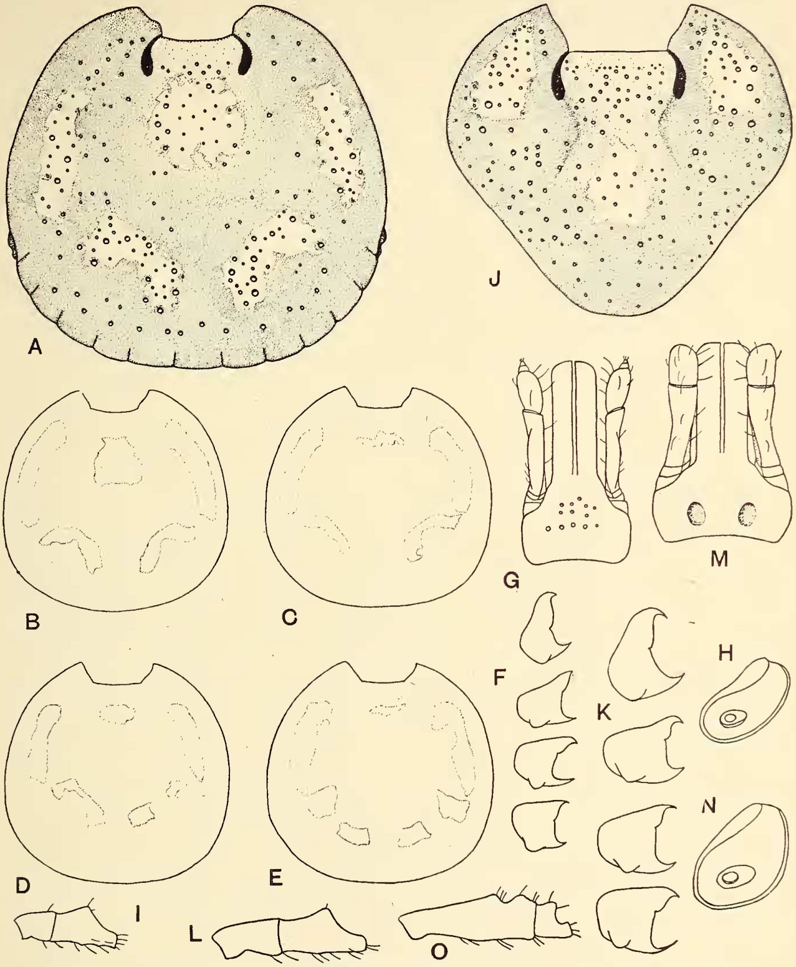

Fig. 29. *Aponomma trimaculatum* (Lucas). A–I, male: A, scutum; B, C, D, E, variations of pattern of scutum; F, coxae I–IV; G, capitulum in dorsal view; H, spiracle; I, tarsus IV. J–O, female: J, scutum; K, coxae I–IV; L, tarsus IV; M, capitulum in dorsal view; N, spiracle; O, tarsus I.

Male (Fig. 29A–I). Three specimens, exclusive of capitulum, respectively 2.16, 2.1 and 2.04 mm. long by 2.1, 1.98 and 1.95 mm.

wide. Scutum reddish-brown and ornate, with five metallic-green spots of variable size and shape; median spot nearly circular and slightly behind cervical grooves; two elongate, lateral spots begin at level of median spot and extend a short distance posteriorly to level of fourth pair of legs; posterior spots on each side as two irregular lobes joined by a narrow band; punctations unequal and more restricted to margins and to ornamented regions, making median region less punctate; cervical grooves short, deep and slightly convex externally; festoons broader than long, being set off by a light, marginal band. Ventral body surface wrinkled, punctate, lighter in color and with a few, very short, white hairs; spiracular plates nearly rectangular; genital opening relatively large and opposite coxae II and III; anal opening opposite spiracular plate; genital groove widely divergent; anal groove distinct. Legs light brown and relatively short; tarsus I slightly swollen, with two prominent, dorsal protuberances, tapering abruptly without terminating in a spur; tarsi II–IV with a single, very large, dorsal protuberance slightly beyond mid-length; tapering abruptly from this point and terminating in a very short, inconspicuous spur; very small pulvillus, about one-third as long as claws; coxa I with a single, blunt spur, broader than long; coxae II–IV with a single spur. Capitulum 0.84 mm. long; palps long and narrow; article two slightly over twice as long as article three; basis sub-rectangular and bordered in black; lateral margins slightly convex and posterior margin slightly concave; hypostome dentition 4:4, with approximately twelve teeth per file.

Female (Fig. 29J–O). Scutum of two specimens 1.65 and 1.71 mm. long by 1.86 mm. wide, cordiform, slightly broader than long, lateral angles not well marked, posterior angle not very broad; reddish-brown and ornate, with three metallic-green spots; lateral spots extending into scapular angles, and median spot behind cervical grooves; punctations numerous, fine, unequal and close together; cervical grooves short and deep anteriorly, prolonged posteriorly as a short, shallow groove concave externally. Abdomen lighter in color than scutum, punctate, and with a few, very short hairs; no marginal groove; festoons about as wide as long, with grooves separating them narrow and deep. Ventral body surface finely wrinkled, punctate and with very short, white hairs in posterior half; genital opening opposite coxae II–III; anal opening opposite posterior border of spiracles; spiracles broad and tapering toward top; genital groove distinct. Legs long and light brown; tarsus I long, with three dorsal protuberances and tapering abruptly from last protuberance; tarsi II–IV long, with a distinct, dorsal protuberance and tapering from this point; tarsi without spurs; pulvillus about one-third as long as claws; coxa I with a single spur broader than long; coxae II–IV with a single, blunt, short spur, slightly longer than that of coxa I. Capitulum normal, 0.98 mm. long; basis broad and outlined in black; lateral margins rounded, posterior margin slightly concave; palps long and narrow; article two about twice as long as article three; hypostome dentition 4:4, with approximately twelve teeth per file.

Distribution and Hosts. This species is recorded from the East Indies, New Guinea, New Britain, Australia (?), and Ceylon (?). In the East Indies it has been recorded from Sumatra (Neumann, 1899; Schulze, 1933), Simeuloeë (Warburton, 1926), Aroe Island (Schulze, 1935) and Amboina (Oudemans, 1927).

Specimens were seen from the following localities in the Oriental Regions: New Guinea (Toem, five males off *Varanus indicus,* in Museum of Comparative Zoölogy; Liki Island, two males off *Varanus indicus,* in Museum of Comparative Zoölogy; one male, off *Varanus* collected by W. E. Stickel, August 18, 1944, in Rocky Mountain Laboratory; New Guinea, two males off *Varanus,* in American Museum of Natural History), New Britain (six males off *Varanus* collected January, 1933 by W. F. Coultas, in American Museum of Natural History), New Georgia (Munda, one male, one female off large spotted lizard collected by W. G. Downs, September, 1943, in Rocky Mountain Laboratory; and same locality, three males, two females, one nymph off *Corucia zebrata,* collected by R. W. Brubaker, December 8, 1944, in Museum of Comparative Zoölogy).

SPECIES OF DOUBTFUL OCCURRENCE IN THE EAST INDIES

Amblyomma petersi Karsch, 1878. Neumann determined a female from Java as this species which is strictly African in distribution, and in 1908 he stated that it was *A. testudinarium* and not *A. petersi.*

Amblyomma serpentinum Schulze, 1936. He described and figured a male and female taken in the Hamburg Zoo off *Python molurus bivittatus* which occurs in the Oriental Region. The tick resembles *A. marmoreum* Koch, 1844, and it is probably this species. More than likely it is an African tick gone astray in the zoo.

Haemaphysalis leporis-palustris (Packard, 1869). Neumann in 1897 determined a nymph from Timor off *Paradoxurus.*

This determination is erroneous, for this species only occurs in the New World.

Haemaphysalis parmata Neumann, 1905. Galli-Valerio in 1909 stated that Dr. Narbel found this species on a monkey in Sumatra. This determination is erroneous, for *parmata* is not known to occur outside Africa.

Hyalomma aegyptium (Linnaeus, 1758). This species was reported from Java by de Blieck in 1913 and 1914; it was probably introduced with domestic livestock from India. There are no recent records, and it may have died out.

Rhipicephalus bursa Canestrini and Fanzago, 1877–1878. This is an African species, and Neumann in 1897 recorded one female from Timor taken off *Cervus unicolor equinus.* This is an error in determination.

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